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VOL. CXLIII.—No. 3714] LONDON: FRIDAY EVENING, MARCH 18, 1927 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

DREDGER FOR SALE.

Tenders are Invited for the PURCHASE of a NON-PROPELLING PONTOON BUCKET LADDER DREDGER, complete with Engines, Boiler, Mooring Winches, &c. The vessel was built in 1923 by Messrs. Wm. Simons and Co., Ltd., Renfrew, is 94ft. long, 25ft. 6in. broad, 5ft. 9in. deep, and has a loaded draft of 3ft. It is fitted with a Sand and Shingle Screening and Washing Plant and is capable of dredging from a depth of 20ft. below water level.

It is offered for sale complete as it stands at Mumbra (G.I.P. Rly.), Bombay. The dredger is capable of being converted into a hopper filling dredger at a small cost.

Offers should be submitted by 8th April, 1927.

For further particulars apply to the DIRECTOR-GENERAL, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1. 5016

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 1st April, 1927, for ACCELERATED and LOW-PRESSURE HOT WATER HEATING at Walsall Post Office and Telephone Exchange.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4982

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 1st April, 1927, for ACCELERATED LOW-PRESSURE HOT WATER HEATING and SUPPLY at Plymouth Station Sorting Office.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4956

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

ONE METRE-GAUGE STEAM RAIL COACH.

Tenders due on the 29th March, 1927.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 5012

Civil Engineer Required by the GOVERNMENT of DOMINICA, to fill the Post of Colonial Engineer and Surveyor-General in that Colony for three years' service, with possible extension. Salary £425, rising to £450 a year, with free passages. Candidates, age 25 to 35, should be Members or Associate Members of the Institution of Civil Engineers and should be qualified surveyors. If possible, they should also have some knowledge of road construction and must be able to ride. The officer appointed will be Head of the Public Works Department and will be required to exercise supervision over the telephone and electric light services; the construction of roads and the surveys of Crown land will also be under his control.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, mentioning this paper and quoting M/15269. 5015

Civil Engineer Required by the GOVERNMENT of NYASALAND for a tour of thirty-six months' service and possible extension. Salary £500 a year. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 30, must be A.M.I.C.E. or hold equivalent professional qualifications and have had good experience on road survey and construction. Experience in the design and erection of steel and timber bridges and buildings is also necessary. Must be able to ride a motor bicycle.—Apply at once by letter, stating age, qualifications and experience, and mentioning this paper, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/15160. 4998

The Government of INDIA REQUIRE the SERVICES of TWO ASSISTANT FOREMEN for the GUN CARRIAGE FACTORY, JUBBULPORE.

APPOINTMENT 89.—Must have served apprenticeship in an up-to-date machine shop and have sound general education. Should be able to fix rates on work passing through shops and estimate from drawings, and preferably have experience of ordnance work in carriage branch. Practical experience of the machinery (more especially boring) of recuperators, also knowledge of broaching, would be useful. Organising as well as practical ability required. Age should not be more than 30 years.

APPOINTMENT 90.—Must be a smith by trade and have served a regular apprenticeship and preferably worked on Q.F. equipment. Experience of hydraulic press, drop stamp work, and modern methods of heat treatment required. Experience of ordnance work in Carriage Branch desirable. Able to fix rates on work passing through shops and estimate from drawings. Able to impart instruction to others with tact and firmness. Age should not be more than 30 years.

Salary (for both appointments) Rs. 450-15-510 per calendar month, with prospects of further increases.

TERMS.—Agreement for five years in the first instance. Free second-class passage to India and return passage on satisfactory termination of services. Free quarters. Medical examination.

Further particulars and forms of application may be obtained (on request by postcard quoting the number of the appointment) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Dept., 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 30th March, 1927. 4985

The Engineer

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PUBLIC NOTICES

Rubacrete Limited.
(In Voluntary Liquidation).

SALE OF RUBACRETE PATENT

The LIQUIDATOR invites OFFERS to PURCHASE the following PATENTS and TRADE MARK :—

PATENTS :

Great Britain, No. 220,679, dated 22nd March, 1923. Term 16 years.

Great Britain, No. 208,679, dated 31st May, 1923. Term 16 years.

Great Britain, No. 227,153, dated 11th September, 1923. Term 14 years.

Canada, No. 239,486, dated 22nd April, 1924. Term 16 years.

France, No. 570,758, dated 21st January, 1924. Term 15 years.

TRADE MARK :

Great Britain, No. 436,375, dated 4th September, 1923. Term 14 years.

The above relates to "Improvements in Methods of Roads and Pavement Construction and the Manufacture of Tiles, Paving Slabs or Blocks for Use in Road Paving, in which Rubber is Used in Conjunction with Concrete."

Copies of the specification can be obtained on application from the Liquidator, and with each application a deposit of 5s. should be sent, which will be returned upon receipt of a bona fide Offer.

Offers should reach the Liquidator not later than Noon on the 31st March, 1927.

The Liquidator does not bind himself to accept the lowest or any Offer.

Dated this 9th day of March, 1927.

H. TANSLEY WITT,
Liquidator.

5, Chancery-lane, W.C. 2. 4987 ii

In the High Court of Justice, Chancery Division. 1926. C. 655.
Mr. Justice Tomlin.
In the matter of CROFTS (ENGINEERS), Limited, and Reduced;
and
In the matter of the COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that a PETITION presented to the High Court of Justice on the 18th day of November 1926 for CONFIRMING the REDUCTION of the CAPITAL of the above Company from Two Hundred and Fifty Thousand Pounds to One Hundred and Fifty Thousand Pounds is directed to be HEARD before Mr. Justice Tomlin on the 29th day of MARCH, 1927.

Dated this 16th day of March, 1927.

J. B. SOMERVILLE,
11, New-square, Lincoln's Inn, W.C. 2,
Agent for F. G. and H. E. SMITH,
33, Kirkgate, Bradford, Yorkshire,
5032 Solicitors for the said Company.

PUBLIC NOTICES

City of Liverpool.
CITY ENGINEER'S DEPARTMENT.
TRAMWAY MATERIAL.

The Corporation are prepared to receive TENDERS for the SUPPLY and DELIVERY of various classes of TRAMWAY MATERIALS as under :—

Schedule No. 1.—Steel Tramway Rails and Fish-plates.
Schedule No. 2.—Steel Fish Bolts.
Schedule No. 3.—Steel Tie Bars.
Schedule No. 4.—Copper Bonds.

Firms are required to state clearly, when making application for the necessary Tender forms, the name and number of the schedule for which they desire to be furnished with Tender form.

Duplicate forms of Tender for record purposes will NOT be supplied.

Forms of Tender will be forwarded upon receipt of application in writing to

The City Engineer,
Municipal Buildings, Dale-street, Liverpool.

Tenders must be sealed and enclosed in the official envelopes provided, endorsed in accordance with the instructions given on the form of Tender, and forwarded through the post addressed to

The Town Clerk,
Municipal Buildings, Liverpool.

Latest time and date for receipt of Tenders Ten o'clock a.m. on Thursday, 31st March, 1927.

WALTER MOON,
Town Clerk.

14th March, 1927. 5010

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

23 M.G. 4-WHEEL STEEL BRAKE VANS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Brake Vans," must be left with the undersigned not later than Twelve Noon on Friday, the 1st April, 1927.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specification.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 9, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1,
15th March, 1927. 5011

PUBLIC NOTICES

Administrative County of LONDON.

EASTERN APPROACHES TO A NEW LAMBETH BRIDGE, VIZ., THE WIDENING AND RAISING OF A PART OF ALBERT EMBANKMENT, THE WIDENING, RAISING AND DIVERSION OF A PART OF LAMBETH ROAD, AND THE RECONSTRUCTION OF THE CONDUIT TRAMWAYS IN THESE ROADS.

The London County Council invites TENDERS for the WORKS to be executed in connection with the formation of the EASTERN APPROACHES to a NEW LAMBETH BRIDGE, viz., the WIDENING and RAISING of a PART of ALBERT EMBANKMENT, the WIDENING, RAISING and DIVERSION of a PART of LAMBETH ROAD, and the RECONSTRUCTION of the CONDUIT TRAMWAYS in these roads.

The works also include the Partial Reconstruction of the Four Bridges (spans about 20ft. to 30ft.) carrying the Albert Embankment over dock entrances, the Construction of Concrete Retaining Walls and Paving Works.

The contractor will be required to use the track rails with their fastenings, slot rails, conductor tees, and the special work for the points and crossings, &c., which will be provided by the Council under other contracts, but all the remaining metal work and other materials will be included in the contract.

Persons desiring to Tender may obtain the specifications, bills of quantities, forms of Tender, drawings, &c., on application to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, on and after Monday, 21st March, 1927, upon payment of the sum of £5. This amount will be returnable only if a bona fide Tender is submitted and not withdrawn. Full particulars for the work and conditions of contract may be seen at the Old County Hall before payment of this fee.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 11th April, 1927, will be considered. The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
4978 Clerk of the London County Council.

Corporation of Durban, Natal.

The Corporation of Durban, Natal, is prepared to receive TENDERS (from manufacturers only) for the SUPPLY and DELIVERY F.O.B. Port or C.I.F. Durban, of :—

9½ MILES 6600-VOLT CABLE.
17 MILES COMBINED PILOT and TELEPHONE CABLE.

On depositing £3 3s., returned on receipt of bona fide Tender, specifications can be obtained from, and sealed and endorsed Tenders (in quadruplicate), marked "Cable," must be delivered to the undersigned on or before the 28th March, 1927.

The Consulting Engineers, to whom application for any further technical information should be made, are Messrs. Merz and McLellan, 32, Victoria-street, Westminster, S.W. 1.

The Corporation does not bind itself to accept the lowest or any Tender.

By Order,
WEBSTER, STEEL AND CO.,
36, Leadenhall-street, London, E.C. 3,
5006 Agents to the Corporation of Durban.

Surrey County Council.
HIGHWAYS AND BRIDGES DEPARTMENT.

The Surrey County Council invite TENDERS for :—

1. The RECONSTRUCTION of SIDLOW BRIDGES, situated on the Reigate-Hookwood Main Road (A.217), about 2 miles south of Reigate.
2. The WIDENING of NEW CHAPEL GREEN BRIDGE, situated on the London-Eastbourne Main Road (A.22), about 4 miles south of Godstone.

Copies of the forms of Tender, instructions to persons desirous of tendering and bills of quantites, may be obtained from the undersigned, and the forms of contract, general conditions, specifications and drawings may be examined at the office of the County Surveyor on weekdays (except Saturdays) from 10 a.m. to 4.30 p.m., on and after Tuesday, 22nd March, on payment of a deposit of £5 5s. for each bridge, which amount will be refunded upon the receipt of the above-mentioned documents complete with a bona fide Tender or Tenders. Each Tender must be enclosed in a sealed envelope, endorsed "Tender for Bridges," and lodged not later than 9 a.m. on the 5th April, 1927

The Council does not bind itself to accept the lowest or any Tender.

W. P. ROBINSON, Assoc. M. Inst. C.E.,
County Surveyor.
Milner-road Annexe, Kingston-on-Thames,
16th March, 1927. 5020

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PUBLIC NOTICES

B. B. & C. I. Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 30th March, 1927, TENDERS for the SUPPLY of :—

BOLTS, NUTS, RIVETS, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1.
14th March, 1927. 5009

Metropolitan Water Board.

MAINS—KEMPTON PARK PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of the undermentioned approximate LENGTHS of CAST IRON WATER MAIN and CONNECTIONS from and to the Filters, Pumps and Reservoirs at the Board's Works at Kempton Park, Hanworth, in the County of Middlesex, and across the Hanworth/Sunbury Road, together with the CONSTRUCTION of a CONCRETE SUCTION TANK and other contingent WORKS, namely :—

358	Lin. Yards of	60in.	diameter	Cast Iron Main.
963	do.	54in.	do.	do.
404	do.	48in.	do.	do.
317	do.	42in.	do.	do.
126	do.	36in.	do.	do.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201), on and after 28th March, 1927.

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained from the Chief Engineer on and after 4th April, 1927, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheque must be made payable to the "Metropolitan Water Board" and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Mains, Kempton Park Pumping Station," must be delivered at the offices of the Board (Room 122) not later than 10 a.m. on Monday, 25th April, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
16th March, 1927. 5018

Metropolitan Water Board.

PRIMARY FILTERS, KEMPTON PARK WORKS.

The Metropolitan Water Board invite TENDERS for the CONSTRUCTION of 24 REINFORCED CONCRETE PRIMARY RAPID FILTERS, each about 26ft. by 16ft. 6in., COMPRESSOR and PUMP HOUSE, WASH WATER TANK, SLUDGE BEDS, REINFORCED CONCRETE FILTERED WATER CULVERT, together with the LAYING of incidental MAINS and DRAINS, the CONSTRUCTION of ROADS and PATHS and ANCILLAEY WORKS in connection therewith at Kempton Park, Hanworth, in the County of Middlesex.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201), on and after 21st March, 1927.

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained from the Chief Engineer on and after 28th March, 1927, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the "Metropolitan Water Board" and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Primary Filters, Kempton," must be delivered at the offices of the Board (Room 122) not later than 10 a.m. on Monday, 25th April, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
16th March, 1927. 5017

MACHINE TOOLS AND PLANT FOR SALE.

The Metropolitan Asylums

BOARD invite OFFERS for the PURCHASE of :—

ONE 7in. by 4ft. 6in. Griffen English Lathe Co. SCREW-CUTTING LATHE.
ONE 6in. by 4ft. 6in. Bradford Mill Co. SCREW-CUTTING LATHE.
ONE 8in. by 6ft. American Tool Works S.S. and S. LATHE.
ONE 9in. by 6ft. Barker and Chard S.S. and S. LATHE.
ONE Sunderland 5B GEAR PLANER (J. Parkinson and Sons).
ONE Richmond GAS MUFFLE FURNACE, 2ft. 7in. by 1ft. 8in. by 3ft. 10in. inside measurements.

All the items are in good working order and the machine tools are complete with accessories. They may be inspected at the Mead Works, Carnwath-road, Fulham, London, S.W. 6, on application to the Engineer-Superintendent.—Offers for all or any of the items should be addressed to the CLERK TO THE BOARD Metropolitan Asylums Board, Victoria Embankment, London, E.C. 4. 4999

The South Metropolitan Gas

COMPANY has a VACANCY on its Constructional Staff for an ENGINEER.

The duties will be wholly those pertaining to the design and erection of new and the remodelling of old plant. Experience in the conduct of a gas undertaking would be helpful and a sound scientific education is indispensable.

Salary £1000 per annum.

Applications to be addressed to the undersigned.

FRANK DAY,
Secretary.

5008 By Order.

The Bombay Electric Supply

AND TRAMWAYS CO., LTD.
APPOINTMENT OF CHIEF ENGINEER.

The above Company have a VACANCY for a CHIEF ENGINEER to take complete charge under the General Manager of the whole of their engineering departments, involving operation, maintenance and extension work in connection with a large electric supply and tramway system.

Age not to exceed 40. Three years' agreement in the first instance. Commencing salary, including overseas allowance, Rupees 2100 per month, with yearly increments of Rupees 100 up to a maximum of Rupees 2500 per month. Provident Fund and other privileges and allowances in accordance with the Company's Standing Orders.—Further information can be obtained from, and applications should be addressed in writing to, A. T. COOPER, M. Inst. C.E., 8, Stone-buildings, Lincoln's Inn, London, W.C. 2. 4977

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a STRUCTURAL ENGINEER, to Fill a Senior Post with a British Firm in India who have Structural Steel and General Engineering Works. Should have A.M.I.C.E. or equivalent qualifications. Must have had good technical and practical training, also drawing-office, workshop and commercial experience. Age 30 to 35. Good salary and prospects to a suitable man.—Address, P2952, The Engineer Office. P2952 A

WANTED by Consulting Engineers, a First-class ASSISTANT, with experience in the Design of all classes of Steel and Reinforced Concrete Buildings. —Address, stating age, experience and salary required, 5034, The Engineer Office. 5034 A

WANTED for Motor Repair Works, ENGINEER, with works and college training preferred, age about 25; must be able to drive.—Address, giving experience and salary expected, P2937, The Engineer Office. P2937 A

WANTED, JUNIOR ASSISTANT ENGINEER for West of England.—Address, stating qualification, age, and salary required, 5023, The Engineer Office. 5023 A

WANTED, JUNIOR ASSISTANT ENGINEER for West of England.—Address, stating qualification, age, and salary required, 4953, The Engineer Office. 4953 A

AN ESTIMATOR, Accustomed to Light General Engineering.—State age, experienced, and salary required, to Messrs. G. D. PETERS and CO., Ltd., Slough. 5027 A

AN ESTIMATOR, Accustomed to Upholstery Work. —State age, experience, and salary required to Messrs. G. D. PETERS and CO., Ltd., Slough. 5028 A

ENGINEER REQUIRED for Cotton Seed Oil Mill in Turkey. Power, Crossley suction gas engine. Good prospects for suitable man. Single man preferred.—Apply, TURKISH TRADING CO., 81, Cannon-street, London. P2938 A

ENGINEER REQUIRED for Managerial Position in Marketing Company. Must be competent to advise on questions of modern road practice and must have commercial experience.—Address, P2935, The Engineer Office. P2935 A

ENGINEERING DRAUGHTSMAN REQUIRED, conversant with Tar-macadam Crushing and Screening Plant. Salary £260 p.a.—Address, 5019, The Engineer Office. 5019 A

ESTIMATOR and TECHNICAL ASSISTANT REQUIRED for large well-known Firm of General Ironfounders and Engineers. Splendid prospects and good salary to tip-top man with experience in Heavy and Light Castings and all classes of Machining, able to prepare estimates at competitive prices without supervision.—Address, stating age, experience, and salary, 4931, The Engineer Office. 4931 A

LIFT FIRM in London (Well Known) REQUIRES MAN in Estimating Department; must be quick, having experience in design and estimating of modern Lifts; no others need apply. State age, experience, and salary required.—Address, 4994, The Engineer Office. 4994 A

MECHANICAL ENGINEERS, Active, WANTED, to join owner in Management of a General Engineering Works in the North of England. Should have Foundry, Works and Drawing-office experience. State age and salary required.—Address, P2929, The Engineer Office. P2929 A

STEAM LOCOMOTIVE ENGINEER, with Good connection, preferably with knowledge of German, REQUIRED by large Continental Firm to deal with Oversea Locomotive Business in London office. State full details of qualifications, experience, age, and salary required.—Address, 5000, The Engineer Office 5000 A

WORKS COST CLERK: Must be Practical Man, fully conversant with Process Costs (Machine Shop, Forging, Erection), Stores Control.—Write, giving detailed experience, age, salary expected, and when disengaged, FRANCOIS CEMENTATION CO., Ltd., Bentley Works, Doncaster. Mark envelope "Cost Clerk." 4990 A

WANTED, DRAUGHTSMAN, Accustomed to Narrow-gauge Rolling Stock, Wagons and Carriages.—Address, stating full particulars and salary required, 4979, The Engineer Office. 4979 A

WANTED, DRAUGHTSMAN, Accustomed to Internal Combustion Engineering, principally for gear-boxes and frames.—Address, stating full experience and salary required, 4980, The Engineer Office. 4980 A

SITUATIONS OPEN (continued)

DESIGNING DRAUGHTSMAN, with Experience in Submarine Mines, Torpedoes or similar work. Give full details of technical training and experience. —Address, P2965, The Engineer Office. P2965 A

DRAUGHTSMAN REQUIRED Temporarily. One experienced in Mechanical Detail Work Design on Compressors essential.—Address, stating age, experience and salary required, 4995, The Engineer Office. 4995 A

DRAUGHTSMAN, Senior, REQUIRED for Baum Washeries. Competent to design all details with minimum supervision. Only experienced men need apply. Permanent post for suitable man. State age, salary, full details.—NORTONS (TIVIDALE), Ltd., Tipton, Staffs. 5021 A

DRAUGHTSMAN WANTED, Accustomed to All types of Elevating and Conveying Machinery. State age, experience, salary required, and whether married or single.—ROBERT BOBY, Ltd., Bury St. Edmunds, Suffolk. 4991 A

DRAUGHTSMAN WANTED, with Good Technical and practical knowledge of Water-tube Boilers and Superheaters, costing experience also desirable.—Apply by letter, stating age, experience, and salary required, H. and T. DANKS (NETHERTON), Ltd., Dudley. 5024 A

DRAUGHTSMAN, with Coal handling and Structural experience, for London Office.—Address, stating age, experience and salary required, P2968, The Engineer Office. P2968 A

EXPERIENCED LOCOMOTIVE DRAUGHTSMAN for Works in Lancashire.—Address in confidence, stating age, experience, and salary required, 5030, The Engineer Office. 5030 A

FIRST-CLASS BRIDGE DRAUGHTSMAN REQUIRED for Engineer's Office in London.—Address, with full particulars of experience, age and salary required, 5035, The Engineer Office. 5035 A

OIL ENGINE DRAUGHTSMEN.—Old-established Firm in the Midlands have VACANCIES for experienced DRAUGHTSMEN for Heavy Oil Engine Work.—Address, stating full details of experience, age, and salary required, 5025, The Engineer Office. 5025 A

STRUCTURAL DRAUGHTSMAN, Thoroughly Accustomed to detailing, WANTED in Manchester. Good salary to first-class man. State age and full experience.—Address, 5026, The Engineer Office. 5026 A

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE the SERVICES of a CHIEF DRAUGHTSMAN with a general engineering experience. Capable of taking full control of drawing-office. Experience in Blast-furnace and Foundry Practice preferable.—Apply in writing in confidence, stating age and experience, to the MANAGING DIRECTOR, c/o the above. 5001 A

INDIA.—MACHINE SHOP FOREMAN REQUIRED, with thorough knowledge of modern practice in Steel Railway Wagon Work. Age 26-30 years. Single man preferred.—Write, with details of experience and copies of testimonials, to Z.S. 850, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 5007 A

GOOD FITTER and MILLWRIGHT WANTED; used to Screening and Crushing Plant. Able to do own running repairs.—Address, 5022, The Engineer Office. 5022 A

SITUATIONS WANTED

ADVERTISER, at Present Holding Responsible position in India with well-known engineering firm, will shortly be free to TAKE up another POST. He desires to get into touch with engineering firms of standing who require an able representative in India. He has first-class technical ability and eight years' selling experience throughout India and Burma. He can show an excellent record as an engineer salesman. Special knowledge railway and contractors' plant, machine tools, oil engines, steam engines, and agricultural machinery, also structural steel work and general engineering.—For full particulars address, P2950, The Engineer Office. P2950 B

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A Seven-Day Journal

M. Daniel Berthelot.

By the sudden death in Paris of Monsieur Daniel Berthelot there is removed from our midst a most distinguished professor of physics and chemistry and an experimenter who contributed largely to the practical application of chemistry to industrial progress. He was born in Paris in November, 1865, and was the second son of the illustrious chemist, Marcellin Berthelot, whose centenary will be celebrated shortly. Daniel Berthelot early showed a predilection for physical and chemical research, beginning with some valuable contributions on fluids and continuing with means of determining high temperatures, the atomic weight of bodies, the physico-chemical action of light, and the chemical activity of ultra-violet rays. His work on fermentation was also of considerable value. Of late years he took an active part in the investigation of liquid fuel problems. A member of the various committees which were formed to deal with the national fuel question, he did much to advance the problem of power alcohol, the hydrogenation of coal and the preparation of various petrol substitutes, and he rendered great service by the clearness and precision with which he popularised those subjects in conferences and lectures. He was professor of physics at the Ecole Supérieure de Pharmacie, member of the Académie de Médicine, Académie des Sciences, and the Société des Ingénieurs Civils de France. Monsieur Daniel Berthelot readily gave his services to all scientific research work, and he was closely associated with many industrial undertakings. It is remarked that notwithstanding his scientific achievements and the valuable work he accomplished for the country's industrial progress, Monsieur Daniel Berthelot received no "decoration" of any kind. In view of the forthcoming centenary celebration of Marcellin Berthelot, the French Government will be asked to vote a sum of one million francs for the erection of a memorial building which will be used as the headquarters of the Office International de la Chimie.

The Armstrong Siddeley Development Company.

The company hitherto known as the Armstrong Whitworth Development Company, Ltd., has now, as a result of resolutions passed at an extraordinary general meeting on Monday of this week, become the Armstrong Siddeley Development Company, Ltd. The original company was formed in 1919 upon the amalgamation of the motor car, aircraft engine and aircraft business of the Siddeley Deasy Company with the motor department of Sir W. G. Armstrong, Whitworth and Co., Ltd. It was the owner of Armstrong Siddeley Motors, Ltd., an undertaking engaged in the manufacture of motor cars and aircraft engines, and of Sir W. G. Armstrong, Whitworth Aircraft, Ltd., an undertaking manufacturing aircraft—chiefly aeroplanes of all-steel construction. In addition the Development Company owned 250,000 ordinary shares in the electrical manufacturing firm, Crompton and Co., Ltd., of Chelmsford. The change in the name of the company has been led up to by the fact that its assets consist principally of those coming under the heading of the Armstrong Siddeley activities. In addition, Sir W. G. Armstrong, Whitworth and Co., Ltd., have disposed of their holding of ordinary shares in the company and will not use it for any developments in the future, whereas it will so be used by the Armstrong Siddeley Company. Accompanying the change of name the articles of association have been altered to increase the interest on the preference shares from 6 per cent. non-cumulative to 6½ per cent. cumulative.

The Manchester Steam Users' Association.

In its report on the seventy-second year's activity of the Manchester Steam Users' Association the Committee of Management states that during 1926 the total number of examinations of boilers made was 26,045, and that of this number 11,264 were classified as internal, flue or entire examinations, the remainder being external examinations. The Committee continues to be in a position to claim that during the whole course of the Association's existence no preventable explosion has occurred to any boiler which has borne its guarantee and certificate of safety. Since the last report the Association has recorded the occurrence, outside its ranks, of fifty-five explosions in the United Kingdom, resulting in the deaths of ten persons and injury to fifty-one others. Of these explosions fifteen, involving four deaths and injuries to nine other persons, were boiler explosions proper, the remainder being explosions from steam pipes, stop valves, kiers, drying cylinders, bakers' ovens, and so forth. The Committee reports that it is taking action in connection with the "Factories (No. 2) Bill" introduced last year with the object of obtaining amendments designed to secure the safe working of boilers without the imposition of undue restrictions and to produce smooth and harmonious relations between boiler owners and the Government authorities. The report calls special attention to the fact that by arrangement with the Inland Revenue subscriptions paid to the Association are to be allowed as trade expenses, and can therefore be deducted by members in arriving at their liability to income tax under Schedule D.

The Australian Wireless Beam Stations.

The short-wave wireless beam stations which have been built for the British Post Office by Marconi's Wireless Telegraph Company, Ltd., at Grimsby and Skegness, for communication with Australia, have successfully passed their official seven days' test, and the Marconi Company has been informed by the General Post Office that the stations have more than fulfilled the conditions required. The guarantees provide that the stations for the Australian service shall be capable of communication at a speed of 500 letters per minute each way, exclusive of any repetitions necessary to ensure accuracy, during a daily average of seven hours, and that a demonstration fulfilling this condition shall be given by actual working for seven consecutive days. This test took place between the 7th and 14th of the present month, and a report from the company which is operating the service in Australia states that during the first six days of the test the average number of words telegraphed each way per day amounted to 148,000, this being equivalent to a speed of 103 five-letter words per minute each way throughout the whole twenty-four hours. At the end of the seven days this average was raised to substantially 150,000 words per day, with a corresponding increase in the average speed. The actual speed of working for the hours during which communication was effected is estimated to have been 148 five-letter words per minute. During the test the speeds were not pressed up to the highest possible point, but on many occasions traffic was dealt with at speeds of 225 words per minute, and high-speed duplex communication was carried out during the seven days for an average period of over thirteen hours per day.

Street Accident Prevention.

On Monday of next week an important conference on street accidents, convened by the Minister of Transport, is to be opened in the hall of the Institution of Civil Engineers in London. From the agenda, a copy of which has been sent to us, it is clear that if certain of the proposals to be submitted are carried, and in due course are made effective, automobile and highway engineers and others will be affected in various ways. We observe, for instance, that one proposal, submitted by the Coroners' Association, would make the fitting of four-wheel brakes compulsory, while another, submitted by the Chiswick Urban District Council, would make it compulsory for all vehicles to be examined periodically with the object of the efficiency of their brakes and steering gear being certified. The Ealing Borough Council is to propose that it should be rendered compulsory for all vehicles to be constructed with the driver's seat on the right-hand side. The Association of London Omnibus Proprietors is to propose that tramway cars should be fitted with automatic stop signalling devices. The London County Council wants a study made of the relation between street accidents and the emission of smoke and grit from steam vehicles. The London Cartage and Haulage Contractors' Association desires to see the pavement in busy thoroughfares railed off in certain places to prevent pedestrians stepping off recklessly into the road. The Automobile Association seeks a higher standard of highway illumination outside the well-lit central areas. The Wood Green Urban District Council proposes that the multiplicity of motor warning signs should be discouraged, that standard signs should be adopted, and that the erection of such signs by private individuals without authority should be prohibited. Altogether there are on the agenda forty-one proposals submitted by some twenty different bodies.

German Shipping Progress.

The progress which has been made by the two principal German shipping companies, the Hamburg-American Line and the North German Lloyd Company during the past year is measured to some extent by the resumption of dividend payments, which in the case of both companies amounts to 6 per cent. The past year was notable in the case of the Hamburg-American Line for the purchase of the German-built steamers Cleveland, Reliance and Resolute from the United American Lines, and the taking over of the Austral, Kosmos and Stinnes lines. The company also added to its fleet the 21,000-ton geared turbine twin-screw liner Hamburg, which will be shortly followed by the sister vessel the New York, both ships being constructed by Blohm and Voss, at Hamburg. The new construction programme includes two motor passenger vessels and seven motor cargo vessels, all of about 9000 to 10,000 tons gross. This year the North German Lloyd Company celebrates its seventieth anniversary since it was founded in Bremen in 1857. A noteworthy ship of the company was the Kaiser Wilhelm der Grosse, of 1897, which, with a horse-power of 28,000, attained a mean speed of from 22 to 23 knots and gained the honour of being the fastest Atlantic vessel of its time. The new building programme of the North German Lloyd Company provides for the construction of two 42,000 gross tons first-class liners, which are to be designed for a speed of over 26 knots, and will be propelled by high-pressure geared steam turbine machinery. These two liners are to be built at Bremen and Hamburg, and will be named the Bremen and Europa respectively. The company has also under construction a number of motor vessels and steamers for its cargo-carrying services.

The Late Mr. J. L. Leslie.

It is with regret that we learn of the death of Mr. John L. Leslie, the superintendent engineer of the British India Steam Navigation Company, Ltd., at the age of sixty-three. Mr. Leslie entered the service of his company as junior engineer in 1885, and at the age of twenty-five was made a chief engineer. A great part of his career was in the East, and from 1912 until the end of the war he was superintendent engineer at Calcutta. The war years brought considerable responsibility and anxiety to the company's executive staff, on account of the many vessels requisitioned for transport work, and the large number of engineer officers required for active service. After the war Mr. Leslie was appointed superintendent engineer in London, and he followed with active interest all the recent developments in marine engineering practice. The British India Line at an early date added motor vessels to its large fleet of steamers, and notable ships of this type were the Domala and Dumana and the Durenoa and Dwarka, which were fitted with North British-Diesel oil engines. Another ship of the company's, the Dalgoma, has Stephen-Sulzer machinery. Mr. Leslie had a wide circle of friends and his loss will be keenly felt in marine circles.

A Large Electrically-propelled Oil Tanker.

The order which has been placed with Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, for an oil tanker of 12,500 tons deadweight carrying capacity for the Atlantic Refinery Company, of Philadelphia, Pa., is a more than usually interesting one. The ship will have a length of 469ft., with a beam of 63ft. and a depth moulded of 35ft. 6in., and she will be electrically propelled. The generator engines will be of the Carels-Ingersoll-Rand type, and will comprise four six-cylinder units, each designed for a normal output of 750 B.H.P. at 225 r.p.m., working on the single-acting airless injection principle. Each engine will be directly connected to a direct-current 250-volt dynamo, and the single-screw main propelling motor, which will be of the double armature type, is to have a designed output of 2800 B.H.P. at 95 r.p.m., which power is suitable for a sea speed of 11 knots. The whole of the electrical equipment will be supplied by the British Thomson-Houston Company, Ltd., of Rugby, and the engines are to be built by Carels, of Ghent. Messrs. Scotts are to build the ships and install the machinery. In type and design the engine will be exactly similar to that already installed in the other ships of the Atlantic Refinery Company's electrically propelled fleet, five of which vessels are now in operation, and three others under construction in America. Interesting features of the new tanker will be the employment of electrically driven rotary oil cargo pumps, and the small power required for auxiliary machinery, which, we are informed, will only amount to about 1½ per cent. of the total shaft horse-power developed. The consulting engineer for the owners in connection with this order is Mr. Lester M. Goldsmith.

The New P. and O. Liners.

We understand that tenders have been invited for the construction of one or more fast mail steamers for the service of the Peninsular and Oriental Steam Navigation Company. The specification particulars are briefly as follows:—Gross tonnage, 19,000; speed, about 18 knots, with a total shaft horse-power of about 17,000. High-pressure geared turbine machinery is called for, working at a steam pressure of 350 lb. per square inch. The steam is to be supplied by a combined installation of water-tube and Scotch boilers, designed to work at a pressure of 375 lb., the boilers being fired with oil fuel. The auxiliary machinery is to be electrically operated with the exception of the circulating pumps, and the current for lighting and power purposes will be supplied from turbo-generators. The machinery specified accords closely with the approved P. and O. practice, the company being one of the few large British shipping concerns which has not yet added motor vessels to its fleet.

The Speed Trials of H.M.S. Amazon.

In a Journal note published in our last issue we referred to the good preliminary trial run of the new Thornycroft-built destroyer H.M.S. Amazon, which recently underwent her official trials on the Clyde. We are now able to state that on Saturday last, March 12th, during her six hours' full-speed trials, although her contract speed was only 37 knots, the Amazon attained a mean speed of 37·47 knots. Her mean speed over the measured mile was nearly 38 knots, or to be precise 37·96 knots.

The Cardington Airship Shed and Mooring Tower.

No. III.*

Mooring Operations.

Before we pass on to describe the equipment of winches at the base of the tower and the manner in which the winding operations are controlled, it will be convenient if we give a brief description of the procedure followed in mooring an airship to the tower and in releasing her subsequently from it.

During the war it was found that while airships could fly in practically any weather, they could only be housed in their sheds or taken out therefrom in favourable weather conditions. The shedding operations required a landing party of from 200 to 300 men. In 1919 experiments conducted at Pulham with the airship R 24 showed that moored to a "mast" an airship could ride safely at anchor for several weeks in the face of winds up to 35 miles an hour accompanied by heavy rain and gusts up to 43 miles an hour. In the system of mooring then used, the airship was hauled in to the "mast" along as nearly a horizontal path as possible by means of a single rope. As the vessel approached the mast, "surging" developed, and considerable risk of causing damage to her was incurred. The improved system now in use was developed in 1921 in the course of experiments with the airship R 33. By means of it that airship was landed without difficulty in winds up to 28 miles an hour, and safely rode out winds up to 50 miles an hour. A staff of only twelve men was found sufficient for the operations involved. The Air Ministry's method of mooring has since been thoroughly tested, not only in this country, but in the United States, where seven towers of the Ministry's type have been erected and used successfully.

The general scheme of the mooring system now in use may be gathered from the diagram given in Fig. 11. When about to "land," the airship approaches the tower in the up-wind direction at a height of from 600ft. to 1000ft. From her nose a main hauling wire is let down to the ground, and its end is secured by the ground staff to the hauling wire from the tower head. The airship is then ballasted up until the united wires are taut and nearly vertical. Hauling-in is begun, and when the airship has been pulled down to about 600ft. from the tower head two side guys are dropped from her nose to the ground. These guys are run through two snatch blocks anchored on the ground, and thence through two fair leads so placed as to give the guys a straight run into the machinery house, where they are coupled to two side guy winches. In future equipments it may be possible to operate both the side guys by means of a single winch. The snatch blocks are spaced round the tower on a circle of 750ft. radius. There are twenty-four of them in all, so that the airship may be handled by means of two of them whatever the direction of the wind may be.

Under the control of the officer at the tower head, the winches on the ground are operated to bring the nose of the airship down to the cup of the telescopic arm. When engagement has been effected, the arm is locked in the vertical position, the recoil portion is locked down to the racking portion, and the ship's cone is locked within the cup. At a later period the mooring cable may be detached from the ship's cone, for it is no longer required for anchoring purposes, and in its place there may be attached a slipping pennant, a short cable extending down the telescopic arm to a quick-release link and lever-slipping device. Just before the airship is due to depart from the tower, the three pins in the cup are drawn back out of engagement with the ship's cone, and the whole anchorage restraint is transferred to the pennant. The slipping device is then operated, and the airship rises, taking the pennant with her.

Winch Equipment.

The machinery house at the base of the tower contains three steam-driven winches, all of the same design and power. The two side winches operate the side guys as indicated above. The central winch operates the main hauling cable, which passes from the nose of the airship down the telescopic a m and the tower to a fairlead anchored to the ground, and thence into the machinery house. All three winches are under the complete control of operators at the tower head, and, in addition, can in the case of a breakdown be controlled from the ground in accordance with orders telephoned from the tower head. The whole of the winch equipment and the control system was supplied by Babcock and Wilcox, Ltd.

The Air Ministry's specification called for a winch with a hauling drum 5ft. in diameter, a normal hauling speed of 50ft. per minute, and a maximum hauling speed of 1¼ to two times the normal. The normal drum shaft speed being fixed by these requirements at about 3 r.p.m., it was decided to run the engine at a normal speed of 150 r.p.m., and to couple it to the winch drum through two reductions, each of 7·07 to 1, giving a total reduction of 50 to 1. The low engine speed of 150 r.p.m. entailed a low piston velocity and consequently made the use of a high steam pressure unsuitable. It was therefore decided to fit a reducing valve in the steam main, and to reduce the boiler pressure of 200 lb. per square inch to 80 lb. at the engine. Further, as the control of the winch required the engine to be fitted with a hunting gear and as the engine was to have two cranks and to be able to start in any position, it was clear that the steam would have to be used in the cylinders practically without expansion.

The design of engine evolved to meet these conditions is illustrated in section in Fig. 12. The engine has twin cylinders, 12in. diameter by 8in. stroke, and is fitted with piston valves and with crossheads working in trunks. It is totally enclosed, and is provided with forced lubrication. Between the crank shaft and the first pinion of the reduction train, a friction clutch, adjusted to slip under a load of 16 tons on the winding rope, is fitted. This clutch is necessary because the engine is strong enough in certain positions of the cranks to break the rope, should it foul anywhere. The engine is separate from the winch, but the two bed-plates are attached at a faced joint in order that the thrust of the reduction gearing may be accommodated.

An end view of the engine and winch is given on page 300, and in Fig. 13 we reproduce a general arrangement drawing of the set. The engine drives a second motion shaft, which, in turn, drives on to a large gear wheel keyed to one end of the drum shaft. At the other end of the drum shaft—the end illustrated on page 300—there is a driving clutch, whereby the drum, mounted to float on ball bearings on the drum shaft, may be connected to that shaft for hauling or paying out purposes. This clutch operates by the contraction or expansion of a friction strap, which passes round a turned surface on the end of the drum. At the gear train end the drum is fitted with a band brake. With the clutch out and the brake on, the load can be held in any position.

In fronts of the drum, on the side remote from the engine—see page 300—there is a right and left-handed threaded shaft which constitutes a reversing screw for the paying-on gear. This shaft has a diameter of 6in. and a pitch of 6¼in. corresponding to a thread angle of 45 deg. This angle of 45 deg., the makers state, is the most efficient that can be used for the purpose and permits an easy passage for the "cod-piece" over the spaces at which the threads cross. As the pitch of the rope coils on the drum is ⅞in., it follows that the paying-on shaft has to make one turn for seven turns of the drum. This slow speed, obtained by means of a chain-driven reducing gear, is claimed to assist the reversal of the direction of travel of the cod-piece at the ends of the shaft.

The operation of the winch calls for the exercise of control over the speed and direction of rotation of the engine, over the engagement and disengagement of the clutch on the drum, and over the application and release of the band brake.

The control of the engine speed and direction is effected by means of a variable-throw excentric gear similar in principle to that employed for ships' steering engines. The gear is illustrated in Fig. 14. The two excentrics are mounted on a side shaft driven by gearing from the engine crank shaft. Each excentric sheave is mounted to slide on a pair of flat faces formed on the side shaft and is held endwise thereon by a split collar. The side shaft is hollow and inside it there is a sliding member in which two sets of slots with inclined bases are cut. Each sheave embraces a pair of wedges fitting within the slots and bearing against the inclined bases. By these means endwise movement of the sliding member can be made to vary the throws of the two excentrics simultaneously from full forward through zero to full reverse. The sliding member rotates with the valve shaft. Relative endwise movement can be effected either by means of a hand lever fitted to a ball race at one end of the sliding member or by means of a variable-speed electric motor at the other end. The lever is used for emergency hand control and the motor for the normal control from the tower head. The motor spindle is coupled through 5 to 1 gearing to a nut surrounding a screwed extension of the sliding member. If the motor is set to rotate the nut at the same speed and in the same direction as the side shaft is rotating, no movement of the sliding member will occur. That member will move endwise in one direction or the other according as the motor speed is increased or decreased. Beyond the nut the extension of the sliding member carries an electrical contact barrel, the purpose of which, as will be explained presently,

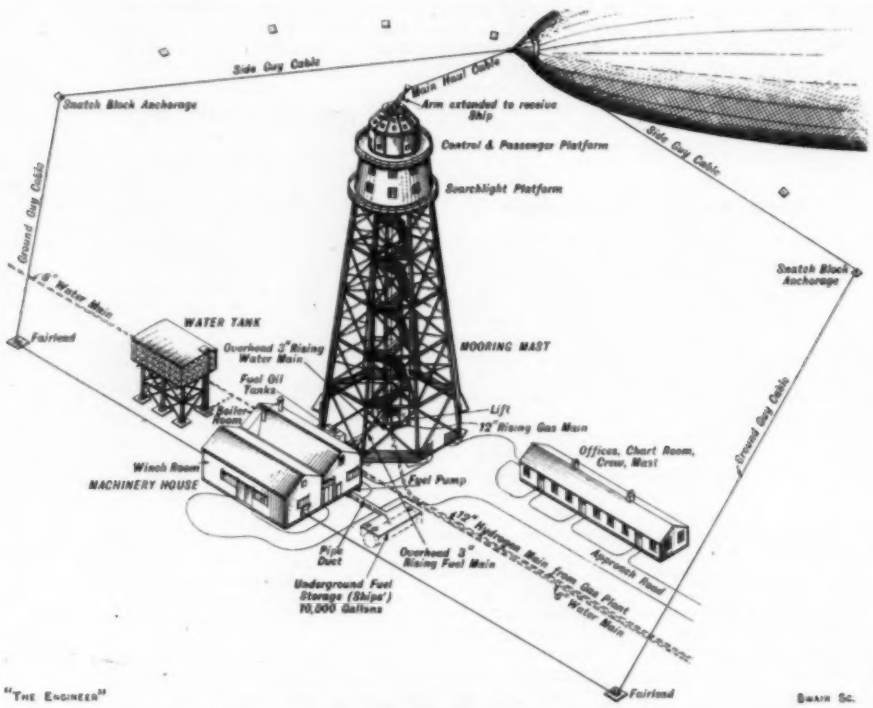


FIG. 11—DIAGRAM ILLUSTRATING MOORING OPERATIONS

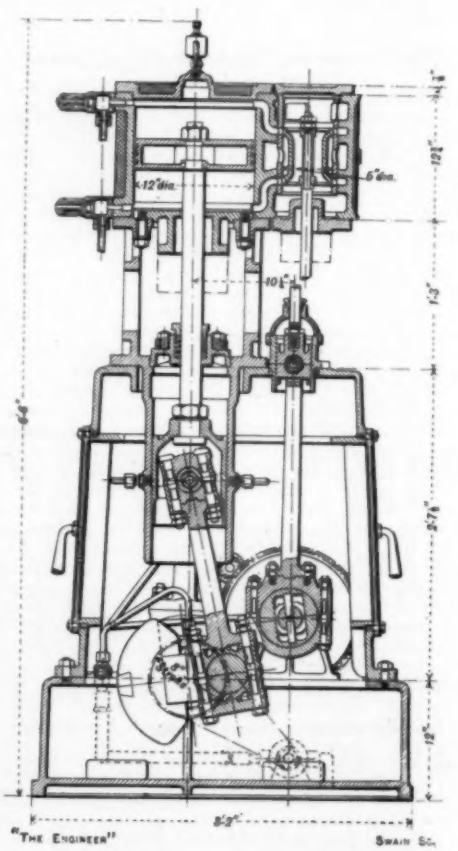


FIG. 12—SECTION OF WINCH ENGINE

* No. II. appeared March 11th.

is to control the illumination of signal lamps at the tower head which indicate the setting of the engine to the operator in charge of the winch controls. The arrangement includes a system of limit switches which come into action and shut down the motor in the event between the valve and the piston is that in the cylinder ports.

The friction clutch on the drum is normally operated by a reversing electric motor—shown to the left in the upper view, page 300—which is started in either direction from a push button control at the tower head. The motor is automatically stopped when the clutch reaches the full-in or full-out position by self-replacing limit switches. In this case also an emergency hand control is fitted and an electrical contact system is provided which operates signal lamps at the tower head indicating the position of the clutch.

which is exhausted by means of a steam jet fitted to the winch engine. A standard vacuum brake control lever is fitted as part of the winch equipment, but normally the control of the brake is exercised from a similar lever situated at the tower head. The setting of the brake is not signalled electrically to the tower head. Instead a gauge indicating the vacuum in the brake cylinder shows the operator whether the brake is off or on.

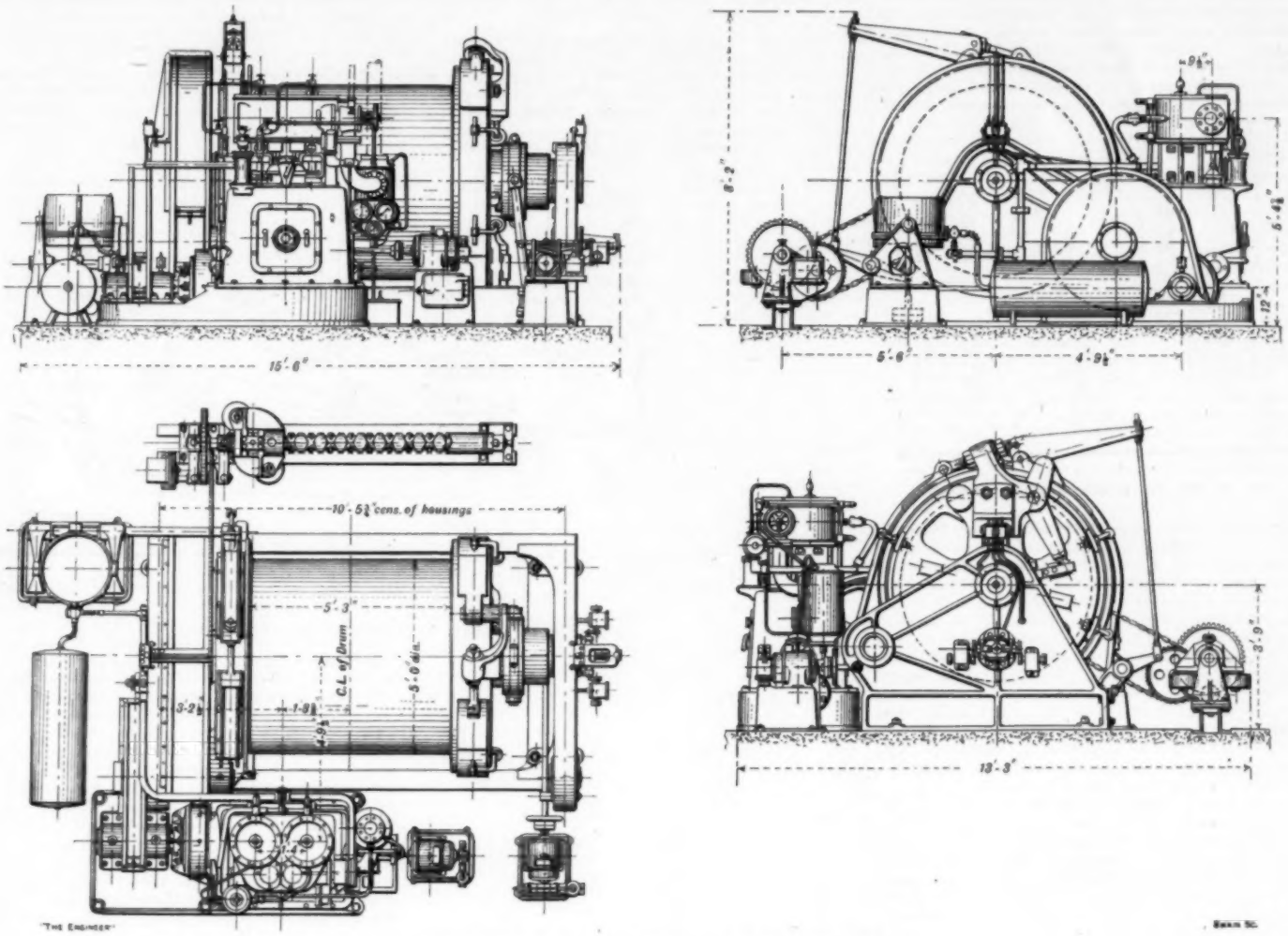


FIG. 13—GENERAL ARRANGEMENT OF ENGINE AND WINCH

of the sliding member being overwound in either direction.

It is claimed by Babcock and Wilcox that this design of hunting gear gives a considerably closer control than the ordinary pattern found in steering engines, the reason being that the steam valves themselves are used to cut off and reverse the steam supply instead of an entirely separate valve. With a separate valve the whole clearance volume between it and the engine piston is filled with steam, which expands and prolongs the period required to change the speed or stop the engine. In the Babcock and Wilcox gear, as described and illustrated above, the only steam

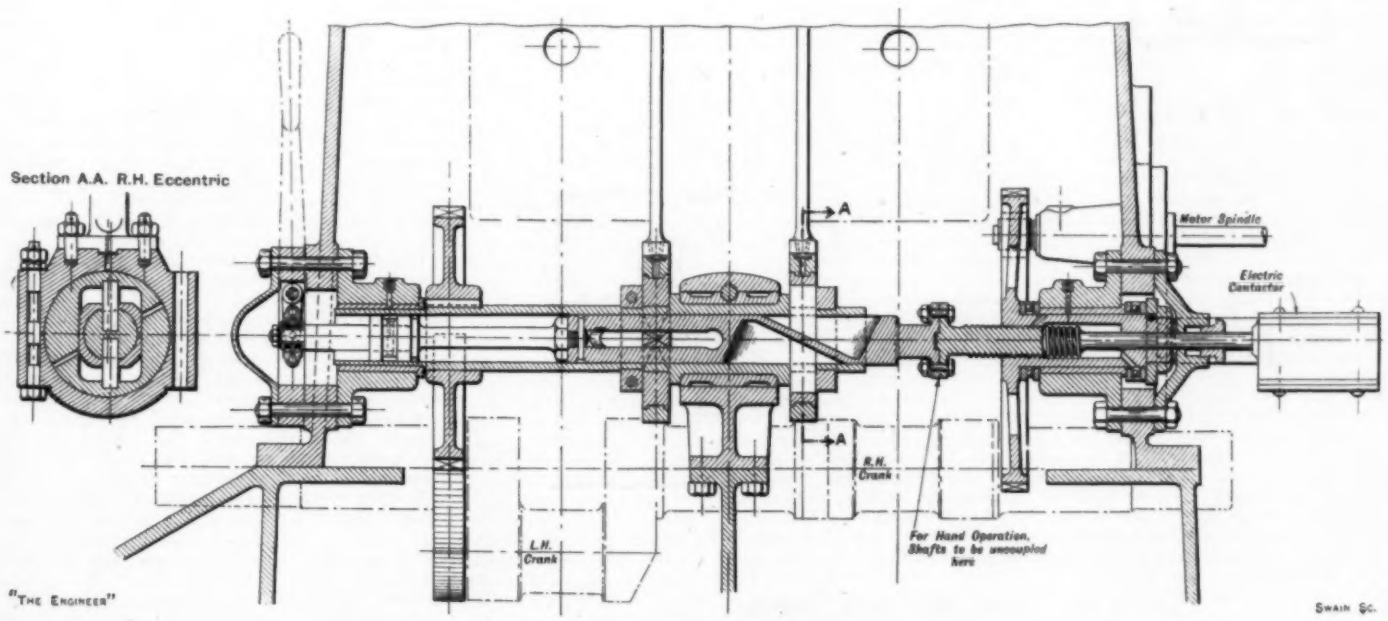


FIG. 14—VALVE GEAR OF WINCH ENGINE

The band brake at the opposite end of the drum is operated on the Vacuum Brake Company's principle as used on railway trains. The vacuum cylinder piston-rod, as shown in one of the end views in Fig. 13, is coupled by a lever and rod to the lever of the brake. It is connected in the usual way to a vacuum receiver

MACHINERY CONTROL EQUIPMENT.

The distant control of the winches is exercised from the passengers' platform at the head of the tower. Each of the three winches is controlled from a separate cabinet attached to the platform railings and each such cabinet is duplicated on the opposite side of the platform. The two groups of three cabinets are arranged on a diameter coinciding with the average

direction of the wind in order to afford the best chance that the airship approaching up wind shall be well within the view of the operators during the mooring process.

All six cabinets are indentical in design. In Fig. 15 we give a plan of the top of one of the cabinets. At A is indicated the vacuum handle controlling the application of the band brake to the winch drum, and at B the vacuum gauge which shows whether the brake is off or on. At C there is a pair of push buttons, the operation of which starts the clutch motor in one direction or the other to engage or disengage the winch clutch. This motor, as we have already stated,

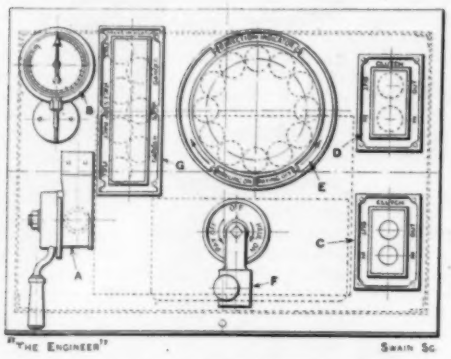


FIG. 15—TOP OF WINCH CONTROL CABINET

automatically stops when the clutch reaches the fully engaged or fully disengaged position, and when either of these positions is reached the fact is indicated to the operator by the illumination of one or other of a pair of lamps represented at D. At E there is a ring of twelve lamps, which are illuminated in turn through the agency of a revolving commutator contact on the winch drum. The speed at which the illuminated point passes round the ring provides a visual indication of the speed of the drum and in addition the direction of rotation of the drum is shown. The motor operating the variable-throw valve gear is governed by the movement of the tramway type controller handle F. Associated with the handle F is a lamp indicator G, which is operated by the contact drum at the end of the winch engine valve shaft and which indicates the setting of the engine valves.

With the handle F in the central or "off" position the valve gear motor is stopped and the central lamp —coloured blue—in the indicator G will be illuminated. The engine with this setting will be stationary or will speedily become stationary as a result of the sliding member screwing itself into the stationary nut and so moving the excentrics into the neutral or zero-throw position. When the handle F is moved to the first notch on either side of the off position the central blue lamp at G goes out and a white lamp on one side or the other of it lights up. The valve gear motor is now running slowly and starts to move the sliding member in one direction or the other, thereby operating the excentrics and through them opening the valves and starting up the engine. As the engine picks up motion the sliding member acquires rotation and eventually when its speed becomes equal to that communicated to the nut by the valve gear motor, its endwise movement ceases. The engine is now running at its lowest speed, namely, at a fifth of the speed of the valve gear motor when the controller handle is at the first notch. If this handle is moved to the second notch the first white lamp at G goes out and a second beyond it is illuminated. The valve gear nut is now running faster than the sliding member and accordingly that member will move endwise until the engine speed rises to one-fifth of the new value of the motor speed. Additional notches for additional speeds are provided on the controller, although only two white lamps for each direction of rotation are provided on the valve indicator G.

Two red lamps indicating danger are provided at G. These lamps become illuminated if for any length of time the valve gear motor should run faster than five times the speed of the engine. If the hauling rope became fouled or if for any other reason too great a load were thrown on the engine the clutch on the engine crank shaft would slip. Should, however, that clutch unaccountably fail to act, the valve gear motor would continue to revolve while the engine was stopped or slowing down and would move the excentrics in the direction of increasing the steam supply to the cylinders. The appropriate red lamp would light up in these conditions and would warn the operator to return the control handle F to the off position. It might happen that the operator's attention had been drawn elsewhere for the moment. To guard against this eventuality the overwinding limit switches are set to come into action and shut down the valve gear motor immediately after the red light becomes illuminated. The control handle has then to be returned to the neutral position before the circuit breaker can be re-set.

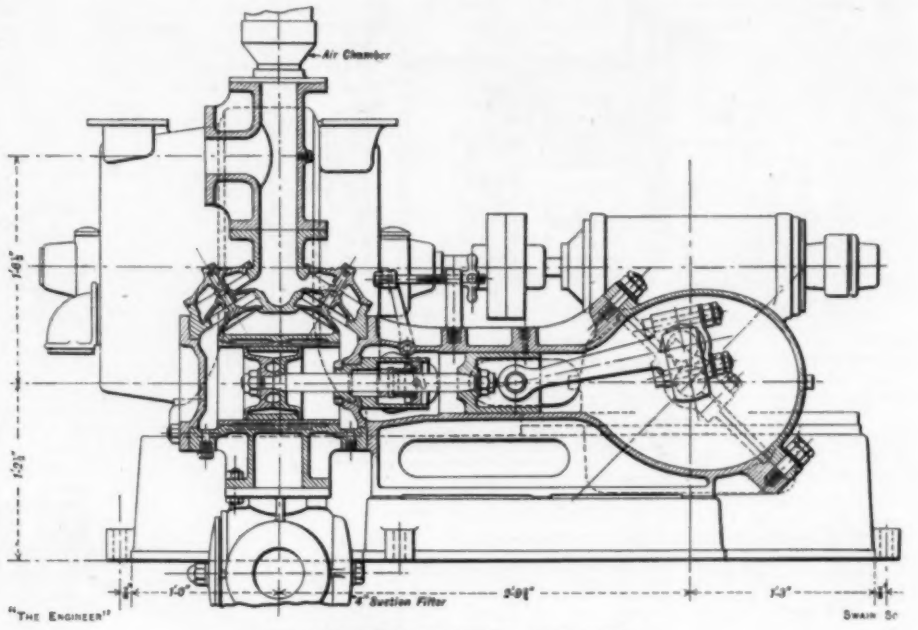


FIG. 17—SECTION OF ZWICKY FUEL PUMP

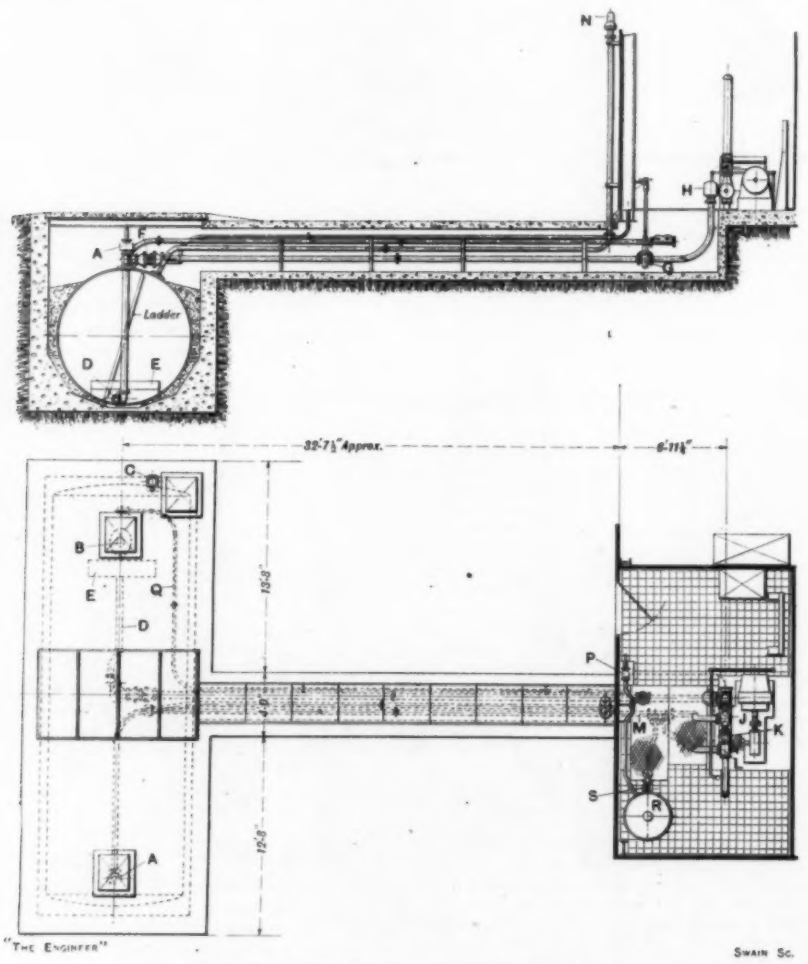


FIG. 16—FUEL STORAGE AND PUMPING EQUIPMENT

The controller F is fitted with the usual "deadman's handle," which must be depressed before the valve gear motor can be started, and which, if accidentally or otherwise released, causes the controller handle to fly back to the neutral position. The controller permits the engine to be run at as low a speed as 50 r.p.m., and at as high a speed as 250 r.p.m., corresponding respectively to rope hauling speeds of about 16ft. and 80ft. per minute. In addition, an "inching" movement may be obtained by tapping the deadman's handle when the controller is in the first notch position. With practice, it is possible by this means to cause the engine to make a single revolution and then stop, corresponding to a rope movement of 3in. When the airship's cone is all but home in the cup, a still finer control can be exercised by tapping the deadman's handle and at the same time applying a slight load by means of the finger control on the vacuum brake lever.

Half-way round the passenger's platform between the two sets of winch control cabinets, there is another control cabinet, whereby the racking and centring machinery for the telescopic arm is governed. This cabinet is furnished with lamp signals, of which a series of six lit in succession indicate the amount by which the main or racking portion is extended from the full-in to the full-out position. The centring motor control is furnished with a red lamp, which remains illuminated until the arm is centralised. These lamp signals are relayed to the winch operators' positions, so that the winching may be effected with a full knowledge of the degree of extension of the telescopic arm.

FUEL STORAGE AND PUMPING EQUIPMENT.

Near the base of the mooring tower a cylindrical tank, capable of holding 10,000 gallons of petrol or other oil fuel, is sunk in an underground concrete chamber. The position of this tank relatively to the tower is shown in the general arrangement drawing accompanying our second article. From the tank pipes are led along a covered trench to a fuel pumping room in the adjacent corner of the machinery house, and from this room the fuel is sent through a 3in. main up the tower to the platform at the top of the conical portion of the turret. The total lift from

the centre line of the tank to the outlet end of the rising main is approximately 204ft.

The fuel storage and pumping equipment was supplied by Zwicky, Ltd., of Slough, Bucks., and is illustrated in Fig. 16. The storage tank is a steel vessel, 9ft. in external diameter and 27ft. long over the dished ends. At A a connection with which is combined a 60-mesh filter is provided for filling the tank from road vehicles. The quantity of fuel in the tank can be ascertained either from a gauge on a board in the pump room or by means of a sounding rod inserted through a sounding pipe at B. The sounding rod, when not in use, is kept under lock and key in a storage pipe at C. Both it and the pump room gauge are calibrated to read to 40-gallon intervals.

The pump suction is effected through an internal pipe provided with a swivelling branch D, the end of which is maintained just below the surface of the fuel by means of a float E. A "Flextel" joint F connects the internal suction pipe with a pipe leading along the trench to the pump and accommodates any expansion and contraction or settling down of the tank that may take place. A sluice valve is provided on the suction pipe at G and a filter of 180-mesh at H. After passing through the pump, the fuel traverses relief valves J, a non-return valve K, and a draining valve L. Should the fuel valve at the tower head be closed when the pump is started, the fuel will escape past the relief valves J and return to the tank by way of the pipe M. The non-return valve K relieves the pump valves of part of the load on them arising from the head of fuel in the rising main. The draining valve L is employed to empty the rising main and return the fuel contained in it to the tank by way of the pipe M. The rising main is provided with "Flextel" joints to accommodate expansion and contraction movements. "Breathing" of the tank is provided for by connecting it to a "Blundell" relief valve N situated outside the pump room.

A hand pump P is connected through a filter of 180 mesh and a stop valve with a suction pipe Q passing into the storage tank and provided with a foot valve at its lower end. Fuel from the lower part of the tank can by means of this hand pump be delivered into an observation tank R, from which it may either be drawn off through a drain or returned to the storage tank by way of the pipe M. An overflow fitted with a non-return valve S is attached to the observation tank to return any excess fuel to the storage tank. The non-return valve S protects the observation tank from any back pressure in the return pipe M when the relief valves J are in action.

To facilitate the cleaning of the storage tank, the fuel can be pumped into the observation tank, and from that vessel passed through a de Laval separator. The purified fuel is returned to the storage tank by way of the common return pipe M.

The gauge board in the pump room carries, in addition to the depth gauge already mentioned, a vacuum gauge connected to the suction side of the pump and a pressure gauge connected to the delivery side.

The pump is of the Zwicky type, and is designed to be capable of pumping 2000 gallons of petrol per hour to a height of 400ft. A section of it is given in Fig. 17. The cylinder has a bore of 6in., and a stroke of 6in., and is made of close-grained galvanised cast iron. It is fitted with a bronze liner. The suction and delivery valves are of phosphor bronze. The suction valves lie below, and are guided in the delivery valves, which, in turn, are guided in the valve covers. The suction branch lies, as shown in Fig. 16, at the side of the cylinder, and not at the foot—an alternative position—as suggested in Fig. 17. This branch is so arranged that the cylinder is always primed. To the suction branch is fitted a Zwicky filter, a feature of which is that the movement of one nut on a central stud enables the filter cage to be withdrawn or tightened. The piston is mounted on a phosphor-bronze rod, and is fitted with a single solid floating ring having a few very shallow grooves turned on its surface. It is claimed that this design of piston, together with the design of the cylinder covers, enables the pump to exert a considerable amount of suction. The piston-rod stuffing-box is of gun-metal, and is held in position by a nut on the inside of the cover. The stuffing-box is extended to form a guide for a ring between which and the stuffing-box gland a spring is inserted. Two levers are mounted, one on each side of the extension, and at the top are united by a cross bar through which passes a stud carrying a hand nut. By the rotation of this nut equal pressure is transmitted to both sides of the ring, and thence through the spring to the gland and packing. If the nut on the stud is loosened sufficiently, the levers fall out of position and permit the gland to be withdrawn down the piston-rod for renewal of the packing. The crank shaft is of 3 per cent. nickel steel, and is mounted in adjustable bronze bearings. A cast iron cover encloses the shaft and the big end of the connecting-rod. Grease lubrication is fitted throughout; the large end of the connecting-rod is supplied through a hole drilled in the crank shaft from a lubricator at the free end of the shaft. The pump is driven at 35 r.p.m. by a 6 horse-power Crompton flame-proof motor, running at 900 r.p.m. The motor is connected to the pump through a flexible coupling and a worm reduction gear fitted with double ball thrust bearings.

In addition to the petrol pumping equipment, pumps are installed at the foot of the tower for raising ballasting water to the airships at the rate of 5000 gallons an hour. A 12in. gas main also runs up the tower for the re-gassing of the airships from the hydrogen-producing plant.

The Machinery House.

The machinery house at the foot of the tower is a steel-framed building, measuring 50ft. 6in. by 57ft. 6in. It is finished with Robertson's asbestos covering, and is divided into two bays. In one bay the three hauling winches are situated. Half of the other bay is devoted to a boiler room, containing two Babcock "portable"-type boilers, each of 997 square feet heating surface, working at 200 lb. per square inch pressure, and fitted with the makers' standard self-contained oil-firing unit. The other half is in part occupied by the driving gear for the passenger lift and by the pumps for the water supply to the tower, and in part is screened off by gas-tight partitions to form a room for the fuel pumping equipment. The whole of this building, together with its concrete foundations, was the work of Braithwaite and Co. (Engineers), Ltd., of London. Messrs. Braithwaite also supplied and erected an elevated pressed steel tank of 1200 gallons capacity to hold fuel oil for the machinery house boilers.

Conclusion.

All the works we have described have been carried out under the direction of Major-General Sir William Liddell, Director of Works and Buildings, Air Ministry, and of Mr. H. E. Oakley, M. Inst. C.E., Deputy Director of the same Department. Lieut.-Col. J. D. K. Restler, M. Inst. C.E., M.I. Mech. E., Chief Mechanical and Electrical Engineer, was responsible for the mechanical and electrical portion of the work. The works were carried out to meet the requirements of the Directorate of Airship Development, which department will take over and operate the plant. The system of mooring which has been described was developed by Major G. H. Scott, of the Airship Development Directorate. The design of the tower head and winch gear was developed by Babcock and Wilcox, Ltd., in conjunction with Major Scott. Mr. A. Hall-Brown was in charge throughout of the work undertaken by that firm. We have to express our thanks to these and other officers of the Air Ministry and to the different contractors for the courtesy and assistance they have shown and accorded us in the compilation of these articles.

Institution of Mechanical Engineers.

THE paper entitled "The Development of Mechanical Vehicles for General Load-carrying Duty in the Army," which Captain C. H. Kuhne, D.S.O., R.A.S.C., presented last Friday evening before the Institution of Mechanical Engineers, in London, attracted a large audience, and produced a prolonged and interesting discussion. Captain Kuhne did not read his paper, but presented it in an informal manner, and illustrated it with a large number of lantern slides and with a highly interesting cinematographic film. The film showed in a striking and convincing manner the capabilities and performance of various patterns of the W.D.-type rigid-frame six-wheeled motor vehicle, in contrast with those of the existing standard subsidy vehicles with four wheels.

In the course of his remarks, Captain Kuhne said that there had been some who had feared that with the introduction of so much that was mechanical into his life, the soldier would degenerate into something little better than an authorised robber. The effect actually had been entirely in the reverse direction. The mechanised army required of its soldiers an increased, not a decreased amount of skill, intelligence and initiative. Describing the rear suspension system used on the W.D. six-wheeled vehicle—see Fig. 1 in the reprint of the paper which we begin elsewhere in this issue—Captain Kuhne intimated that it was the invention of Lieut.-Colonel Niblett. Among the slides which the author showed, additional to those reproducing the illustrations in his paper, were some representing applications of the W.D. six-wheel principle to motor omnibuses, fire-engines, road snow ploughs, and transport wagons for carrying cotton in the Sudan. The snow plough example came from Norway. The vehicle illustrated, Captain Kuhne said, had been found capable of clearing from the roads snow 1½ m. deep at the rate of 15 miles an hour. The Sudan vehicles, he said, when fully laden with 2 tons on the lorry and 1 ton on a trailer, were capable of covering rough ground at 8 miles to the gallon. The six-wheeled W.D. vehicle, he concluded, was not a "stunt" machine, but was very economical. At present the War Office subsidy scheme, involving a payment of £40 a year for three years on each vehicle, extended to a thousand lorries of the four-wheel type. The War Office hoped shortly to be able to offer a similar subsidy to owners of six-wheeled load carriers of the W.D. type.

General Davies, opening the discussion, said that at the War Office a very deep study of mechanical transport for the Army was made by the M.T. Advisory Board, a technical body which included in its numbers four members of the Institution—Sir Henry Fowler, Professor W. E. Dalby, Lieut.-Colonel A. E. Davidson, and Mr. L. A. Legros. Sir Henry Fowler, in particular, had done much, in spite of his railway interests, to develop mechanical transport in the Army on the right lines. Mechanical transport and railway transport, correctly regarded, were complementary, and neither could be done without. In the development of mechanical transport in the Army the liaison between the Army, the manufacturers, the technical Press and the users of the vehicles had meant very much, and he believed that the trust and co-operation displayed would continue to become stronger and stronger as progress was made.

Professor W. E. Dalby remarked that the six-wheeled vehicle which some two or three years ago crossed the Sahara, gave a good account of itself, but was not perfect. The mechanical defects which were disclosed had now all been eliminated, largely by the work of Colonel Niblett. It was very important to have the torque rods properly designed in such a way that they did not move the bogie as a whole. The design of suspension adopted in the W.D. vehicle was very efficient in that it secured the articulation of the wheels without imposing torsional strain on the springs. The axles had full degrees of freedom relatively to the ends of the springs. From his own experience he could assure the meeting that the W.D. six-wheeled vehicle was safer on slopes of 1 in 2½ or 1 in 3 than the film seemed to suggest.

Colonel J. F. C. Fuller stated that since the war an enormous amount of experimental work connected with mechanical transport had been carried out by the War Office. One of the objects aimed at was to get the Army's mechanical transport requirements established on a civil and commercial basis. The full-track, half-track, and six-wheeled vehicles represented three separate attempts to solve the problem. The full-track vehicle was, he thought, essential for capital fighting machines, the movements of which were more or less dictated by the enemy's position or manœuvres. The six-wheeled vehicle seemed to be particularly adapted for use in connection with supplies. It would also, he thought, be suitable for taking the place of the half-track vehicle in the case of auxiliary fighting machines, such as armoured cars and lorries for carrying bridging pontoons and signalling equipment.

Mr. E. S. Shrapnell Smith, speaking as the President of the Commercial Motor Users' Association, congratulated the War Office and its technical and executive officers, who had combined to produce the results which the author had shown on the screen. He had himself witnessed demonstrations of the six-wheeled W.D. vehicle at Aldershot, and was convinced that by its means we had entered upon a new era in commercial road locomotion. The six-wheeled vehicle represented a combination with very wide commercial applications, and he was glad to learn that its use would probably be encouraged shortly by means of a subsidy scheme. Such a scheme would expedite the adoption of the six-wheeler by commercial undertakings. The use of such vehicles would have far-reaching effects in this country, particularly in connection with agriculture, for which purpose it would enable the lorries to pass over meadows and fields to the point of loading, and thence to return to the highway, equally economical results being obtained under both conditions. Again, although the average snowfall in this country was only of eight days' duration per year, the ability to run the vehicles in snow would be a great inducement to users to adopt the six-wheeled type, for by so doing they would avoid the risk of having to leave their vehicles out in snowy weather or of having to withdraw them from service. The six-wheeled vehicle, he repeated, in conclusion, definitely marked an era of the utmost importance in the development of road locomotion.

Mr. L. A. Legros said that it was important that manufacturers should produce six-wheeled vehicles, not only for this country, but also for overseas use, to take goods and produce over bad roads to the railhead, as, for example, in Canada and Australia. The film did not show the behaviour of the six-wheeler over rock-strewn country, but it was quite possible for it to traverse such land at a low speed. The film was undoubtedly a valuable asset for demonstrating the capabilities of the vehicle. He suggested that a "close-up" view of the tires when they were just slipping would be of great value to the tire manufacturers. The arrangement of spare wheel shown in the paper—see Fig. 16—was new, and it would appear to be necessary to provide some form of spring suspension for these wheels. Not enough attention, he thought, was paid by British car manufacturers to the clearing away of small down-hanging parts in the danger zone below the level of the axles. In the Ford and other American cars anything that could pass under the front axle would find practically a straight run through beneath the body, but in British cars it was usual to find the area obstructed by all manner of objects, such as the brake gear, the exhaust and the battery box. This point affected the "belly clearance" of the car when it was passing over rough or hummocky ground. Outside the big towns in the Dominions there were many very bad roads, on which the six-wheeler would be found capable of being satisfactorily employed. Car manufacturers should see to it that they were represented in those countries

by engineers and not only by commercial men. Brakes on road vehicles were not properly provided for under our laws. When a car was going down hill, the front wheels experienced a big proportion of the load, and consequently it was on those wheels that brakes could be most successfully employed.

Colonel-Commandant E. Gibb said that more than anything else the six-wheeler had helped to dissipate the idea of the descent of the military spirit. With a certain amount of misgiving, six-wheelers had at the Aldershot Command Cavalry Brigade Training been used to work in conjunction with the cavalry. The reports received did not show that petrol and oats had failed to mix, but, on the contrary, were optimistic and eulogistic.

Mr. C. Owen Silvers, manager of the Wolverhampton Corporation tramways, spoke as a user of rigid-frame six-wheeled vehicles. He had, he said, had nine months' experience with such vehicles. Dealing with the question of single or double tires on the rear wheels, he said that if one punctured, he found that the other alongside it was of little further use, and was soon put out of action. The forward control position for the driver was favourably regarded by the author, but it was doubtful if it could be successfully combined with the requirements of accessibility. Of the six-wheeled vehicles under his control, one had already done 20,000 miles and the five a total of 50,000 miles. The original tires were still in use, and he fully expected that the 20,000 miles would be doubled before they would require replacement. In the recent snowy weather all the six-wheelers kept to their scheduled time, while the four-wheelers failed to do so. In comparing the results obtained with the six-wheeled and four-wheeled passenger vehicles under his control, he emphasised the fact that the types were not strictly comparable as regarded their tires—one pneumatic and the other solid—their transmission system, their engines—one with sleeve valves, the other with poppet valves—and in other respects. These differences being noted, he said that the four-wheeled solid tire vehicle consumed 0·635 gallon of petrol per 100-seat miles, while the rigid frame six-wheeler with pneumatic tires used only 0·369 gallon, showing a saving of 42 per cent. The unladen weight of the four-wheeler was 360 lb. per seat provided, and that of the six-wheeler 230 lb., a saving of 36 per cent. The six-wheeled vehicles gave better results as regarded acceleration and speed, and in general had been found so satisfactory that it had been decided to replace some of the tramcars with six-wheeled vehicles provided with sixty-five seats.

Major-General S. S. Long referred to his experience with mechanical transport at Aldershot in 1895 and in the South African War. On both occasions it had been unfortunate, but he admitted that within recent times astounding progress had been made. He thought, however, that from the country's point of view, it was a serious matter that we should have a rapidly changing machine that was essential for war purposes. He did not believe that a thousand subsidised six-wheelers would prove anything like sufficient to serve the needs of the Army in the event of an emergency, and he suggested that the subsidy money might more profitably be spent in assisting the Colonies and dependencies to purchase and operate vehicles of the six-wheeled type. Concluding, he referred to the vehicles shown on the film as having been specially tuned up for the demonstration, but on this point we observed Captain Kuhne indicating dissent.

Mr. Sydney Guy remarked that the film did not do the course justice, although it might appear to be quite stiff enough. There were, he said, tremendous possibilities connected with the use of six-wheeled vehicles on hard roads. If large numbers of them could be placed on the roads of this country it would be preferable to having them in the Crown Colonies, as suggested by General Long. The Colonies, he thought, would buy them in any event. Many possible users did not seem to grasp the advantages of the six-wheeler on hard roads. These advantages were not easily to be gathered from the performance of the vehicles on soft ground, as illustrated by the film. Nevertheless, the very features which made possible the feats on soft ground that had been demonstrated were responsible for the advantages possessed on hard roads. The shock was reduced 75 per cent., a feature of great usefulness in the transport of fragile goods over common roads. The most important fact was, however, that wheel spin had virtually been eliminated. Wheel spin in the W.D. six-wheeler would occur only in the unlikely event of two diagonally opposite rear wheels lifting off the ground simultaneously. It did not occur if either pair of wheels on the same axle lost contact. The elimination of wheel spin meant the elimination of rear wheel skidding, and the elimination of skidding meant that a reduced size of engine could be used and a reduction in the wear of the tires. Concluding, he drew attention to the two vehicles B and G referred to in the appendix to the paper, the first a post-war four-wheeled subsidy lorry, and the second a medium six-wheeled lorry. Both vehicles, he said, had the same engine. The four-wheeler carried a useful load of 1½ tons and the six-wheeler one of 3 tons. The draw-bar pull of the six-wheeler was more than 100 per cent. greater than that of the four-wheeler. The average speeds were the same, but the six-wheeler gave 25 ton-miles to the gallon of fuel, while the four-wheeler gave only 20. The six-wheeler could climb a gradient of 1 in 3, whereas the maximum that could be surmounted by the four-wheeler was 1 in 6.

Lieut.-Colonel T. M. Hutchinson remarked that while the six-wheeler had been originated abroad, its development to complete success was the work of our countrymen. In America the six-wheeler had been adopted for passenger service on the road, largely because of its increased riding comfort. The question had been asked why the War Office had patented the system of rear suspension illustrated in Fig. 1 of the paper. The object was to secure the free use of the idea and to avoid a monopoly. Continuing, he remarked that if the front wheels of a six-wheeler dropped into a ditch 2ft. to 3ft. wide, with practically vertical sides, the vehicle virtually became locked. That fact might eventually lead to the development of a front wheel drive, a matter which, he thought, need not prove so expensive as some might anticipate. The six-wheeler undoubtedly had a reduced tendency to skid, but it was difficult to arrange efficient brakes on all the wheels. He did not feel convinced that spring suspension was necessary for the spare wheel, but that wheel had to be placed at some considerable distance in front of the centre of gravity if the vehicle were not to stick on a bank. He hoped to see forward control developed, for it would give increased body space. The provision of the requisite amount of body space was one of the problems of the six-wheeler. Very favourable reports had been received from India regarding the performance of six-wheeled vehicles, particularly on rocky ground. It would be necessary, however, to devote special attention to the cooling arrangements of vehicles intended to be used in the Tropics, and to devise satisfactory means of protecting the engine from dust and sand. He suggested that the use of six-wheelers for civil purposes might be encouraged by a reduction of the tax imposed on them in recognition of the reduced damage they caused to the roads and their reduced liability to cause accidents.

Major E. G. E. Beaumont thought that there always would be a pronounced difference between the mechanical transport requirements of the Army and those of civil life. The front-wheel drive, while valuable for military purposes, would add to the cost and complexity of the six-wheeler, and would not encourage its commercial use. The difficulty might be surmounted by designing the commercial vehicle in such a way that a front wheel drive could readily be added to it when the emergency arose. He would like to see a definite comparison made between the four-wheeler and the six-wheeler. The six-wheeler, he thought, involved expense that would hinder its use commercially unless it possessed superior economy apart from the subsidy received for it. The statement in the paper that the W.D. rear suspension system prevented the application of the driving torque from disturbing the distribution of the weight over the four driving wheels involved, he argued, a fallacy. The torque rods would prevent the deformation of the springs, but would not obviate a redistribution of the load.

Wing Commander S. G. Dalton held that in peace time the Royal Air Force would find more use for the six-wheeler than the Army. It would be of particular value for obtaining access to overseas aerodromes situated in difficult country or to machines that had crashed in fields or elsewhere off the roads. Every aerodrome, he thought, would shortly be provided with a six-wheeled vehicle. The type had been used very successfully in Egypt.

Brigadier-General Mance said that in Irak the mud encountered introduced the element of slipping on the ground as well as sinking into it, and therefore he was very interested to hear about the over-all chains for the driving wheels. What was the weight of the chain? Obviously, on, say, a 600-mile run its weight would be an important factor to consider. What was the effect of the chain on the tires? Could the vehicle be run on the chains for 20 miles without ruining the tires? While he admitted that the ability conferred by the chains to get the vehicle over bad ground was the chief fact to consider, he would like to know to what extent the use of the chains affected the speed obtained from the vehicle. Had the War Office had sufficient experience as yet to enable it to give figures for the relative costs of using single and double-tired wheels?

Captain Kuhne, called upon to reply briefly to the discussion, said that he was glad to learn that the six-wheeled vehicle was proving economical on the road. The subsidy scheme from the point of view of the War Office, did not simply mean the placing on the road of a thousand vehicles suitable in emergency for Army purposes. It meant that such vehicles were brought into the production stage, and that the War Office obtained some control over their design. He could assure Major Beaumont that there was no fallacy in the statement made in the paper regarding the action of the suspension system, provided, as was the case, that the pivoting point was placed near the centre of the two axles. It could be shown that a W.D. six-wheeler, when standing anchored on a weighbridge and called upon to exert its maximum tractive effort, showed no redistribution of the weights on the driving wheels. Replying to General Mance, he said that the chains weighed from 3 cwt. to 4 cwt. At first the chains injured the walls of the tires, but subsequently the design was altered, and the abrasion was reduced to an inconsiderable amount. It could, if necessary, be reduced still further by carrying the non-abrasive rubber used on the treads down the flanks, but that procedure had been found unnecessary. With the chains in position speeds up to 15 m.p.h. could be obtained. Chains for use on single-tired wheels were being developed, but the work had not yet reached the stage at which it could be talked about. So far, not very much was known regarding the relative costs of single and double tires on six-wheeled vehicles. The patent for the W.D. suspension system was not taken out to make things difficult for the manufacturer, but in order that the invention might be made available to all. If any royalty at all was charged for the use of the patent, it would be only about 10s. to 20s. per vehicle, in order to cover the cost of patenting the invention throughout the world.

The World's Future Supplies of Liquid Fuels.

By JOHN B. C. KERSHAW, F.I.C., F.S.S.

No. III.*

THE PRODUCTION OF OILS FROM COAL BY THE BERGIUS PROCESS.

THE Bergius process for the production of liquid fuels from coal or lignite is the invention of Dr. F. Bergius, of Hanover, and is protected in all countries by patents dating from the year 1913 and onwards. The process is based upon the treatment of coal, lignite or other solid carbonaceous materials with hydrogen gas, at temperatures between 400 deg. and 500 deg. Cent., and at pressures between 1500 lb. and 2250 lb.

The chief difficulties met with in developing the process upon an industrial scale have been those relating to the construction of apparatus which will permit a large through-put and continuous working at these high pressures. Dr. Bergius, however, claims as the result of thirteen years of experimental work, to have overcome all of the practical difficulties connected with the translation of the process from a laboratory to an industrial scale of operations. The plant at Rheinau, where the experimental work has been carried out is now, it is reported, being enlarged to a capacity of 100,000 tons of raw fuel per annum, and further developments of the process are expected to occur shortly in Silesia, at the centre of what has been in the past the most productive coal-mining area of South-Eastern Europe.

According to a financial contemporary, all the patents relating to the Bergius process are now owned by the International Bergius Gesellschaft of Amsterdam, and in this company the Royal Dutch Shell group, and a group of German companies, which includes the Badische Anilin and Soda Fabrik, hold equal rights. The financial interests behind the process are therefore very powerful, and it is probable that at an early date steps will be taken to exploit and work it upon an industrial scale in all countries.

As the liquid hydro-carbons produced by the process are very similar to those present in crude petroleum, the further treatment of the liquid products from the Bergius liquefaction process will probably be carried on in the existing oil refineries, and no special plant will be required for dealing with the Bergius products. Another point in favour of the process is that it can be applied to many types of fuel which are now being disposed of as "colliery wastes"; and thus raw materials for the operation of the process ought to be obtainable at a very low cost. The operating expenses, in fact, will be determined chiefly (1) by the cost of the hydrogen gas; and (2) by the interest on the capital expenditure upon, and the maintenance costs of, the plant.

In the writer's opinion, it will, within a few years, be possible to produce synthetic liquid fuels by the Bergius process at a cost but little higher than the price now charged for crude mineral oil, and it is probable that further investigations will show that the process can be operated with the aid of catalysts, at much lower pressures than are now being used. The first cost of the apparatus and the maintenance costs will then be greatly reduced, and a much cheaper product will be obtainable.

With regard to the patents, the earliest English patent is 18,231 of 1914, but the date of claim is August 8th, 1913, so that unless its life is extended this patent will lapse in 1928. As the claims made in this patent are of considerable importance, they are reproduced below:—

(1) A process for manufacturing liquid or easily fusible hydro-carbon compounds from coal or other solid substances produced by natural or artificial carbonisation of vegetable matter, consisting in subjecting the said substances to the action of hydrogen at a pressure of more than 10 atmospheres and at an elevated temperature not exceeding 600 deg. Cent.

(2) A process as set forth in Claim 1 in which the reaction is carried out at a temperature of from 300–500 deg. Cent. and at a pressure of more than 100 atmospheres.

* No. II. appeared March 11th.

(3) A process as set forth in Claims 1 and 2, in which the reaction with hydrogen is allowed to take place during the carbonising of vegetable substances.

(4) A process as set forth in Claims 1 and 3, in which the reaction is carried out in the presence of a solvent, such as petroleum distillates or reaction products formed by the process.

(5) The process of treating coal and other products of carbonisation of vegetable matter substantially as described.

Considering now the question of yields, the most reliable accounts of the operation of the process and of the results obtained are to be found in a paper read by Dr. Bergius in 1924, before the German Chemical Society, in Berlin, and in a lecture delivered by him at Essen, in 1925. In these two deliverances the inventor stated that the reaction between the hydrogen gas and the coal was completed in ten minutes, when temperatures between 400 deg. and 500 deg. Cent. and pressures between 100 and 150 atmospheres were employed; and that when the process was operated continuously, a reaction space of one litre was required to hydrogenate 800 grammes of carbon per hour. With regard to the experimental plant at Mannheim, Dr. Bergius stated that the reaction chamber there had a capacity of 124 cubic feet and that 80 tons of coal could be passed through it per day. The coal employed was mixed with ferric oxide in order that the latter might combine with the sulphur present when the coal was heated; since this impurity in the free state produced polymerisation of the heavy oils, and this increased ultimately, the production of solid coke instead of liquids in the reaction chamber. The coal was kneaded with pitch, and the paste produced in this way was then passed through the apparatus. The details of the mechanical equipment at Rheinau were, however, not revealed.

In his lecture at Essen, the inventor stated that the proportion of hydrogen required to operate the process was only about 5 per cent. of the weight of coal; but that there was no necessity for this hydrogen to be pure, and that if the percentage of this gas amounted to between 70 per cent. and 85 per cent., either carbon monoxide or dioxide might be present as impurities, without endangering the efficiency of the process. The conversion of the solid fuel into the liquid form, under ordinary conditions, amounted to between 40 per cent. and 50 per cent., but in some special cases no less than 70 per cent. of the coal passed through the reaction chamber had been converted into liquid products.

The following figures were given in Berlin by Dr. Bergius for the yield obtained from 100 kilos. of Oberschlesische coal, which tested 28 per cent. of volatile matter, 6 per cent. of ash, and 4 per cent. of moisture:—Oils, 54 kilos. (21 kilos. of which had a b.p. below 230 deg. Cent. and was classed as motor oil, 17 kilos. with a b.p. above 230 deg. Cent. was classed as Diesel oil, and the residue of pitch amounted to 16 kilos.); gas, 15 kilos.; water, 10 kilos.; ash, 6 kilos.; unaltered coal, 15 kilos. About 5 per cent. of this type of coal was converted into phenols, and these are included with the 17 kilos. classed as Diesel oil.

In the lecture delivered at Essen, Dr. Bergius gave another set of figures for the yields obtained from a coal containing 25 per cent. of volatile matter. The figures given below are based upon the English ton of 2240 lb.:—Oil, 857 lb., or 38·2 per cent.; gas, 462 lb., or 20·6 per cent.; water, 165 lb., or 7·3 per cent.; ammonia, 11 lb., or ·5 per cent.; residue (containing oil and coal), 745 lb., or 33·4 per cent. From this residue it was stated a further 176 lb. of oil could be extracted. The liquid products, after purification, gave the following amounts of saleable products:—Motor spirit, 330 lb., or 14·7 per cent. of the solid fuel; impregnating oil, 400 lb., or 17·8 per cent.; lubricating oil, 132 lb., or 5·9 per cent.; fuel oil, 171 lb., or 7·6 per cent. These yields include the 176 lb. of oil contained in the residue from the hydrogenation process and their total amounts to 46·0 per cent. of the original fuel.

As regards independent investigations of the Bergius process, Fischer and Frey have carried out laboratory investigations of the application of the process to various types of solid carbonaceous material, including gas coal, coking coal, non-coking coal, lignite, and a semi-coked product made from lignite, of which a very large amount is produced in Germany, by distilling lignite briquettes at 450 deg. Cent. As the result of their investigations they state that all the fuels tested by them yielded a larger quantity of oil by the Bergius process than could be obtained by direct low-temperature distillation alone.

The ease with which the solid fuel could be hydrogenated depended partly on their physical and partly on their chemical properties, and they found that the crude oil produced by hydrogenation contained up to 20 per cent. of phenols.

Their experiments were carried out in a seamless steel tube with walls 13 mm. thick, and a hydrogen pressure of between 75 and 100 atmospheres was employed. The tube was rotated on its axis at a rate of 11 r.p.m., and temperatures varying from 330 deg. Cent. to 480 deg. Cent. were employed. Their best results were obtained between 425 deg. and 450 deg. Cent., and it was found that the lower the temperature used the longer was the time of heating required, and that this therefore varied from twenty-five minutes up to five hours.

Caking coals were found not to be so readily hydrogenated as non-caking coals; the explanation being that the latter produced on heating a homogeneous product which was much more easily attacked by the hydrogen gas. The yields obtained by hydrogenation were compared with those obtained by distilling the same carbonaceous materials in an aluminium retort; and, as already stated, in every case a larger quantity of oil was obtained by application of the Bergius process.

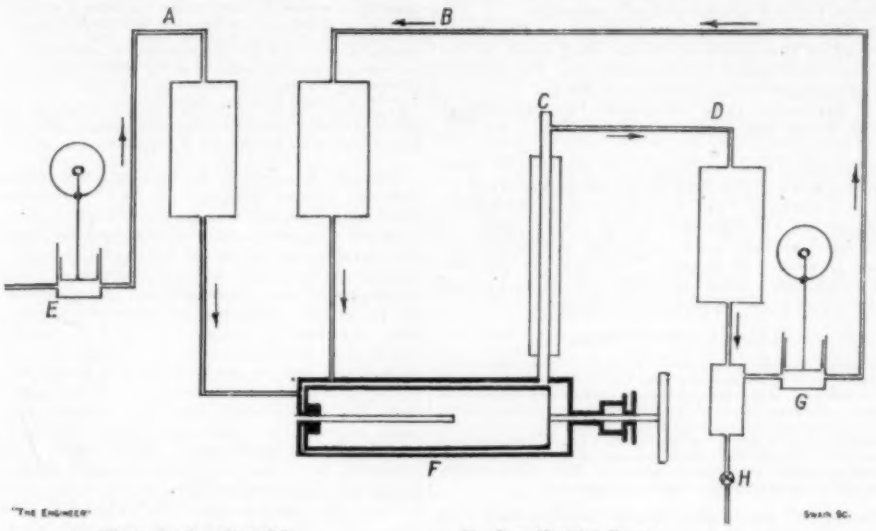
The following figures are given for the treatment of a semi-coke obtained by distilling brown coal briquettes at 450 deg. Cent. and then submitting the coked briquettes to hydrogenation under pressure:—Oils, 45·2 per cent.; water, 8·5 per cent.; ash, 10·1 per cent.; residue, 6·1 per cent.; gaseous matter and losses, 30·1 per cent. In this experiment 42 per cent. of the hydrogen was absorbed by the charge of solid fuel.

Two other German chemists, Tropsche and Ter-Nedden, have also investigated the application of the process to the semi-coke manufactured from lignite, and have given some details of the composition of the oils obtained. Their investigations were carried out with an autoclave at pressures varying from 200 to 260 atmospheres or double those employed by Fischer and Frey, and the oil formed was distilled directly from the reaction vessel. A temperature of 460 deg. Cent. was employed and a period of heating of sixteen hours. Twenty-seven per cent. of water was contained in the distillate, and after separating this and submitting the remaining oil to fractionation 46 per cent. came over under 280 deg. Cent. and 13 per cent. of pitch remained in the autoclave. From the oil distilling under 280 deg. Cent. 22 per cent. of tar acids were separated, and these when fractionated yielded phenols and cresols.

The only description of the plant at Rheinau which has appeared in print, so far as the writer is aware, is one given by Monsieur Andre Kling, chief chemist to the Municipal Laboratory in Paris, based on the result of a visit to Mannheim early in 1924. Two types of apparatus are described, one continuous and the other intermittent in action, and an illustrated description of these will be found in the article which he contributed to the June, 1924, issue of *Chimie et Industrie*.

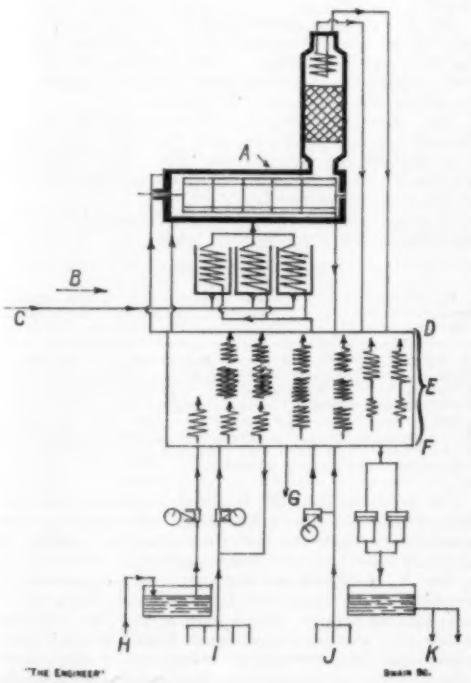
Monsieur Kling was greatly impressed by the methods of control adopted at Rheinau. These were centralised so that the chemist or engineer who was in charge of the operations could regulate the working of the whole plant while sitting at a central control board, which carried the pressure and temperature gauges connected to the reaction tubes and also the valves for controlling the supply of hydrogen gas and fuel. The tube in which the hydrogenation of the fuel was carried out was placed in a chamber which no one was permitted to enter, and in this way the dangers due to the high pressures used were reduced to a minimum.

Before closing this account of the Bergius process it is only fair to state that some adverse criticism has appeared in a paper contributed by two American chemists, Messrs. Fieldner and Brown, to the Symposium on Motor Fuels, held in New York in September, 1925. Messrs. Fieldner and Brown state that, although the Bergius process may be regarded



A. Heater for Raw Materials.
B. Heater for Hydrogen.
C. Reflux Cooler.
D. Condenser.
E. Raw Materials Pump.
F. Reaction Vessel.
G. Hydrogen Pump.
H. Collecting Vessel for Liquid Product.

FIG. 1—DIAGRAM OF BERGIUS APPARATUS FOR INTERMITTENT OPERATION



A. Reaction Vessel.
B. Heaters.
C. Entrance for Heated Oil.
D. Entrance and Exit for the Heated Gases.
E. Heat Interchangers.
F. Entrance and Exit for the Cooled Gases.
G. Drainage Cocks.
H. Crude Oil.
I. Entrance for Hydrogen Gas.
J. Entrance for Furnace Gas.
K. Pipe to the Liquid Product Tank.

FIG. 2—DIAGRAM ILLUSTRATING CONTINUOUS OPERATION

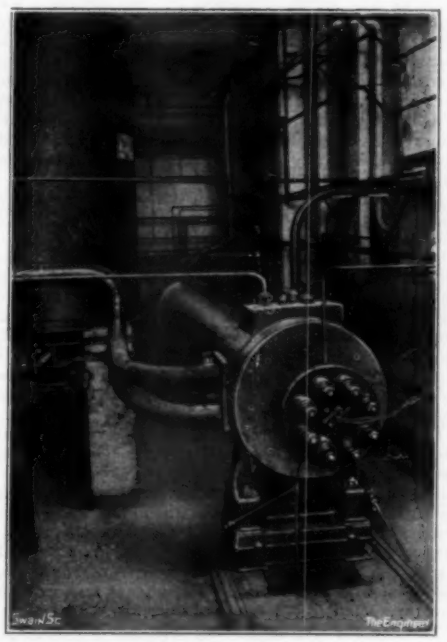


FIG. 3—THE BERGIUS REACTION CHAMBER AT RHEINAU

as one of the possible methods for producing a substitute for petrol in the future, it must be remembered that this is only one of the products of the process, and that the percentage amount contained in the oil is only about the same as in crude petroleum. In their opinion, therefore, the direct synthesis of petrol substitutes from gases would seem to be the more economical process for the purposes of motor fuel production. This criticism has been met by Dr. Bergius by pointing out that the gasification of solid fuel and production of carbon monoxide gas is always allied with a loss of heat units, and that this preliminary gasification of the fuel must add to the expense of the final product.

Another opinion as to the future of the Bergius process is that expressed by H. G. Shatwell in the issue of the *Journal* of the Society of Chemical Industry for May, 1925. This English chemist states that a survey of the literature dealing with "bergiuization" shows that a new and valuable means of producing liquid fuels of low b.p. from heavier hydrocarbons and coke oven tars, also heavier oils from solid carbonaceous substances, has been made available.

To what extent the process will be developed on an industrial scale, Shatwell considers to be yet undecided, but he quotes the fact that Belgian chemists who have investigated the process have published an extremely favourable report, and have stated that on the basis of the prices quoted for liquid fuel in Brussels in 1923 the Bergius process could have been operated in Belgium at that date to show a substantial profit.

The writer's own opinion with regard to the future of the Bergius process has already been given, but it may be added here that the tars and tar oils produced by low-temperature carbonisation will provide another type of raw material, specially suited for hydrogenation under pressure. These tars and tar oils are allied in their physical and chemical characteristics to the tars obtained from lignite, which already have been successfully treated by the Bergius process. Low-temperature tars when distilled yield approximately 35 per cent. of hydrocarbons, 40 to 50 per cent. of phenols, and 20 to 30 per cent. of pitch, and are very suitable for submitting to a process which is comparable to "cracking," with the avoidance of the polymerisation which occurs when the ordinary methods of "cracking" are applied to them.

NOTE.—The illustrations, Figs. 1 and 2, are reproduced from "Chimie et Industrie," by permission of the Editor of that journal.

The Institute of Metals.

No. I.

THE Institute of Metals held its annual general meeting in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, on Wednesday and Thursday, March 9th and 10th, under the presidency of Sir John Dewrance.

The first business was of a formal nature, beginning with the presentation of the annual report and accounts. These reflected a state of affairs which drew from the meeting expressions of congratulation to the President, the Council and staff.

The report states that the number of members on the roll of the Institute on December 31st, 1926, was as follows:—Honorary members, 3; fellow, 1; ordinary members, 1684; student members, 113; total 1801.

In addition to the Liége meeting, held on September 1st to 4th, at which seventeen papers were presented, two other general meetings were held during the year. They were the annual general meeting on March 10th and 11th, and the May Lecture, on May 19th, both taking place in London and being well attended. At the annual general meeting, which was followed by the annual dinner, fifteen papers were presented. Professor H. C. H. Carpenter, F.R.S., Past-president, delivered the sixteenth annual May Lecture on "Single Metallic Crystals and their Properties."

Under the direction of the Committee, Mr. May has continued the investigation of a number of problems connected with the corrosion and protection of condenser tubes. The greater part of the work carried out during the year has been on the formation of protective films and scales, since it is becoming more clearly realised that the good behaviour of brass tubes, under working conditions, frequently depends to an important extent on the presence of such films. Special attention has been given to the influence of iron compounds on film formation, as the presence of iron appears to be an important feature in the more important types of films which are formed naturally. Attempts to produce such films artificially have shown that their formation is more complicated than appeared at first sight. It has been found that the presence of other substances may have a profound effect. If other conditions are suitable, the presence in the liquid of as little as one part per million of certain colloidal materials may be the deciding factor between a good or a bad film.

Considerable success has been obtained in the formation of resistant films in certain silicate solutions. Films of this type have been produced which appear to differ from the films already mentioned in being resistant to deposit attack. The investigation of these films is being actively continued. Valuable information on the deposition of films and scales has been very kindly supplied by the engineers in charge of certain power plants.

Further work has been carried out on the electrical differences which may be set up under certain conditions between the tubes and tube plates of a condenser. The results are of much interest, since they provide a simple explanation of a number of actual cases of condenser tube corrosion for which no satisfactory explanation has been forthcoming in the past.

There has been a good demand during the year for the revised pamphlet prepared by the Committee entitled "Notes on the Corrosion and Protection of Condenser Tubes."

As the result of the ballot, the following members were elected to serve in the capacities indicated for the year 1927:—

President.—Sir John Dewrance, K.B.E.

Vice-presidents.—Mr. T. Bolton, Sir Henry Fowler, K.B.E., LL.D., Dr. W. Rosenhain, D.Sc., F.R.S.

Members of Council.—Mr. R. Lloyd Gibbins, Dr. H. Moore, O.B.E., D.Sc., Ph.D., the Hon. Sir Charles A. Parsons, K.C.B., F.R.S., Mr. A. J. G. Smout, Professor F. C. Thompson, D.Met., Captain H. Vivian.

It was reported by the Secretary that eighty-nine members and eight students had been elected since last September, which was a considerable advance on the figure for any similar period previously.

A hearty welcome was extended by the President, on behalf of the members, to Dr. Max Haas, of the Deutsche Gesellschaft für Metallkunde, the parallel body in Germany to the Institute of Metals.

The President then delivered his presidential address, which was printed almost in full in our last issue.

The reading and discussion of papers was then proceeded with. The first to be taken was Part V. of a paper entitled "The Investigation of the Effects of Impurities on Copper," the preceding parts of which have already been published in the *Journal* of the Institute of Metals. The authors are Dr. Hanson and Miss Ford, and the title of the present part is "The Effect of Bismuth on Copper."

BISMUTH AND COPPER.

This paper describes experiments made on copper containing up to 0·1 per cent. of bismuth, and the effects of small quantities of bismuth on the casting, hot and cold rolling, mechanical properties, electrical conductivity and micro-structure of copper. The experiments confirm the great embrittling effect of bismuth, and indicate that when more than a trace of bismuth alone is present in copper, the working properties, particularly the cold-working properties, are seriously affected. The solid solubility of bismuth in copper has also been investigated.

Opening the discussion, Mr. R. Genders said that it could be taken as fully established that bismuth was not freely soluble in solid copper, and that it formed films around the crystal boundaries. It was fairly safe to assume from that that the ratio of the area of crystal boundary to the amount of bismuth present governed the distribution of the bismuth, whether it was in the form of a continuous film or in separate particles. That led to the conclusion that crystal size must have a very important effect on the mechanical properties of these coppers containing bismuth, or alloys in which bismuth was not soluble. He had had occasion to roll a piece of copper which was cast almost perfectly sound, free from gas and oxygen, the bismuth content being only 0·002 per cent., but it cracked on cold rolling, owing entirely, he believed, to the fact that the crystals were so large, and the area of crystal boundary over which the bismuth was distributed was so small that the bismuth was able to form a continuous film.

Captain L. Taverner pointed to the variability of some of the results obtained by the authors, and suggested that it was due to the presence of something other than bismuth and copper. A good deal of copper was being produced with considerably more bismuth in it that the outside limits mentioned by the authors, and it would be misleading to a number of users to see it stated that the amount of bismuth should not exceed 0·005 per cent. It did exceed that figure considerably in the presence of other impurities.

Dr. W. Rosenhain suggested that it was beside the point to criticise the paper on the ground that it did not give the results obtained when impurities other than bismuth were present with it in the copper, because the research was concerned with the influence of bismuth only on copper. The effect of certain impurities in combination was often very different from the effect of those impurities individually, but before one could determine the effect of combinations of impurities, one must determine the effect of individual impurities. That was all that was being done by the authors.

Dr. R. S. Hutton (British Non-ferrous Metals Research Association) said his Association had asked the National Physical Laboratory to carry out a study of the effect of combinations of antimony and bismuth and arsenic and bismuth. Antimony and arsenic were supposed to have a greater effect when present with bismuth than when present alone. It might cause misunderstanding if a statement that copper should not contain more than a trace of bismuth went out to the world at large.

The President reminded the meeting that the paper was one of a series, which would ultimately be summed up and dealt with as a complete whole.

Miss Ford, replying to the discussion, agreed with Mr. Genders that crystal size would have a very great effect on mechanical properties, but as far as she could judge no films of bismuth were formed when the proportion was as low as 0·002 per cent.; only small isolated particles appeared in that case. The same rate of pouring was adopted throughout the experiments, but there was variation of temperature, and the differences in results were probably due to that fact. In reply to Captain Taverner, she said the castings contained a certain amount of gas.

Two papers, forming Parts III. and IV. of the same general investigation, were then presented by Professor D. Hanson and Mr. C. B. Marryat. They were entitled "The Effect of Arsenic on Copper" and "The Effect of Arsenic, and Arsenic plus Oxygen, on Copper."

ARSENIC AND COPPER.

These sections describe investigations into the effects of arsenic alone, and of arsenic plus oxygen, on copper. The tests described in Part III. have been made on a series of alloys containing up to 1 per cent. of arsenic, and the paper describes the effects of arsenic on the casting and working properties of these materials. Tests have also been made on the mechanical properties—tensile tests at ordinary temperatures and at 250 deg. Cent., hardness tests, fatigue range, and notched bar impact test; while the effects of arsenic on the electric conductivity, both at 20 deg. and 65 deg. Cent., have also been examined. The effects of arsenic on the macrostructure and microstructure of copper have also been determined, and the solubility of arsenic in solid copper has been investigated. In Part IV. a similar series of tests has been carried out on copper containing up to 2 per cent. of arsenic and 0·1 per cent. of oxygen, with a view to ascertaining the influence of each of these elements on the presence of the other. In particular, the influence of arsenic in modifying the cold-shortness of copper containing oxygen has been investigated.

Experiments on the gassing of copper by hydrogen have also been undertaken with a view to ascertaining the influence, if any, of arsenic on the gassing of oxygen-bearing copper.

Captain L. Taverner, opening the discussion, observed that in this paper, as in the preceding one, there were variations in results for which there was apparently no reason, and he suggested that there were considerable quantities of hydrogen present. The amount of hydrogen and the amount of oxygen in copper could vary considerably. A statement made by the authors, that over-rolling occurred only if the ratio of arsenic to oxygen fell below a certain limit, which was approximately 10 : 1, was liable to be misleading, and he did not think it would be borne out by general rolling experience. It was also stated that the experiments described showed that very small amounts of oxygen, as low as 0·016 per cent., had a distinct embrittling effect, which might be corrected by arsenic, but that probably pure copper, completely free from oxygen, would be devoid of that defect. He was not quite clear what was meant by that, and did not think an ordinary electrolytic copper could be described as brittle.

Professor T. Turner (Past-president) said that the only adverse criticism he had heard of these researches was that they had brought out a good deal of information which was already known. The real value of the work, however, was that the investigators had gone over the ground systematically, and had endeavoured, with considerable success to give quantitative values for a single element, where only roughly qualitative values had been available before. Therefore, he did not think the criticism referred to would hold, and the work should be regarded as a step towards a fuller knowledge of the influence of the different constituents when they were present together.

Mr. N. Hubbard agreed with Professor Turner, and considered that the work would add a great deal to metallurgical knowledge. From almost every one of such papers the manufacturers obtained a great deal of useful and applicable information.

Mr. Marryat, replying to Captain Taverner's remarks as to brittleness, said that the cold-rolling test applied was very severe. The 10 : 1 ratio was merely a sort of guide to show in what direction the brittleness would manifest itself.

A paper entitled "Brittleness in Arsenical Copper," by Clement Blazey, was then taken.

ARSENICAL COPPER.

In this paper a description is given of a type of brittleness in arsenical copper tubing developed by annealing in the temperature range 450 deg. to about 650 deg. Cent. The susceptibility to brittleness was inherent in the "as-cast" billets from which the tubes were made, and no alteration in hot and cold working methods could eliminate it. The degree of susceptibility varied from billet to billet, but the variation could not be connected with chemical composition. After remelting, no trace of brittleness could be developed. Over a period of several years the brittleness was encountered in a certain mill on three occasions and appeared to be connected with the composition of the refinery charges and with melting operations.

In the discussion, Mr. R. Genders pointed out that some curious differences were indicated in the paper, and suggested that they were due entirely to gaseous constituents in the copper.

Mr. N. Hubbard said the antimony content of the coppers dealt with was extraordinarily high for a commercial copper, in one case as high as 0·05 per cent. An antimony content of 0·01 was extremely dangerous, and resulted in brittleness of the copper when in the cold condition. The gases present might be a determining factor, but the antimony content would lead one to suspect that the copper would be unworkable in any case. He had experienced remarkable cases of brittleness in copper of absolutely normal analysis, there being present no antimony or anything else known to be deleterious. If the copper were heated to red heat and quenched, the brittleness disappeared, and it was impossible to get it back into that extremely brittle condition again, although by very slow cooling a certain condition of brittleness could be produced. That again suggested that gases might be responsible.

The statement that an antimony content of 0·01 per cent. was dangerous was challenged by Mr. J. H. Grant, who said that for years he had produced copper containing two or three times as much antimony and had had no rejects. When such statements were made the copper manufacturers felt their effect, and, though they might be made by people who were investigating the A B C of the problem, others were

inclined to think that the A B C was the X Y Z, and to condemn the copper as a result.

Mr. R. Lloyd Gibbins, as a user of copper, pointed out that the chemical composition of the coppers dealt with in the paper showed that they contained all the elements necessary for brittleness in commercial copper tubing. There were considerable amounts of phosphorus and lead, and bismuth was also present in most of the samples.

It was indicated that the author, who is in Australia, would reply in writing.

Electric Furnaces.

A paper entitled "Electric Furnaces in Non-ferrous Metallurgy," by Mr. D. F. Campbell, was then taken. It deals in a practical way with the principal electric furnaces now used for melting copper, nickel, zinc and silver, with special reference to induction furnaces of normal and high frequency.

Dr. H. W. Brownsdon criticised the figures given in the author's table illustrating an actual day's run in a 75 kilovolt-ampère Ajax-Wyatt furnace on 61 : 39 brass in Birmingham, and considered that in many ways the figures were rather abnormal than typical. The average number of units consumed per ton of metal melted (206) came in for comment as being extremely low, and he wondered at what temperature the metal was poured. From time-temperature curves, he had taken on the running of an Ajax-Wyatt furnace, he had found that it required from 50 to 55 minutes to melt the metal, and then a certain amount of superheating was required. He could only conceive that the furnace referred to by the author was pouring "cold" metal, and that the quality of the ingots would not be above suspicion. The higher figure of 224 kilowatt-hours per ton for melting 60 : 40 brass for extrusion billets in a 600 lb. Ajax-Wyatt furnace was reasonable. There should not be the prevailing uncertainty with regard to metal losses, which was due to the varying methods of calculating them. A straightforward way to estimate loss, taking the metal put into the furnace as 100, was to ascertain the weight of metal taken out as ingots, and the residue left; then to determine what percentage of that residue was zinc, and what percentage was irrecoverable metal. In the best running conditions he had experienced—and they were somewhat special conditions—the loss had not been less than 1·1 per cent., and was made up of practically 80 per cent. of zinc represented as oxide. When the whole of the recoverable metal had been extracted from the residue and returned to the furnace, a residue equivalent to 1 per cent. of the metal put into the pot still remained. That was exceptionally good running, but under average working conditions, the loss came out at 1·3 per cent., of which about 1·1 per cent. was zinc oxide. Those conditions were obtained when borax was used as a flux, but if borax was not used, the 1·3 per cent. was increased to nearer 2 per cent., and under some working conditions it might easily be still higher. Because the losses were reduced from 2 to 1·3 per cent., however, it did not necessarily mean that anything was gained economically, because borax was an expensive flux, and the residue was so poor in metal that the refinery would not look at it. It might be just as economical to use a flux, such as salt, and so obtain a higher percentage of metal, and it was not always the most economical way of running a furnace which resulted in the least residue. Metal loss appeared to occur in the early stages rather than the later stages of melting. The furnace was heated from the bottom, but he suggested that the Ajax-Wyatt furnace needed an arc at the top, because if there were more heat at the top, and the added scrap were melted more quickly, some of the difficulties might be overcome. A point which Dr. Brownsdon stressed was the neglect of the application of the electric furnace to the annealing of non-ferrous metals in this country—there was just as bright a future for its application to annealing as to melting—as well as to the melting of high-melting-point alloys. He also pointed to the difficulty of obtaining in this country a satisfactory refractory lining for the Ajax-Wyatt furnace even when running on ordinary brass, and regretted that the lining material he used came from America. Electrical energy could be used for annealing so economically that it would quickly displace solid, liquid or gaseous fuels. The whole of the energy, except that lost by radiation, was absorbed into the material, if the design was suitable. In an experimental furnace, which he had running, he had reached the point at which 60 kilowatt-hours per ton was quite a reasonable current consumption for the annealing of brass, and he had no doubt that that could be much improved.

The cause of the arc furnace was championed by Mr. W. R. Barclay, who was disappointed that it had not received more attention in the paper. The greater his experience of the arc, top electrode, type of melting furnace, the greater his admiration for it, and a number of mechanical improvements had been made which tended to lessen the metallurgists' worries and difficulties. In arc furnace melting there was greater elasticity in choice of refractory materials than in others, and the arc furnace had an advantage in that it permitted a certain amount of refining. He admitted all that could be said about the danger of the absorption of carbon from electrodes, and so on, but with proper working that danger could be very much reduced. Though he admitted also the advantages of high-frequency melting, he was not quite sure that he would endorse the author's statement that purer melting could be obtained with the high-frequency furnace than with any other type. It was remarkable what a high degree of purity could be obtained with the arc furnace, properly controlled. The mechanical arrangements of most furnaces left a great deal to be desired, and in that connection he stressed the importance of the collaboration of the metallurgist and the engineer in design. Stressing, also, the advantages of annealing electrically, he pointed out that the electric furnace gave accuracy of control which was not obtainable with any other, and the bogey of cost was not so serious as it would appear to be on paper. If the costs of electric and other furnaces were compared merely on the basis of power consumed, the former would probably be at a disadvantage, but such factors as the cost of transporting material to the furnaces had to be considered also. The costs of that were in many cases astounding, and an advantage of the electric furnace was that it could be brought to the work. A very high standard of insulation could be applied to a modern electric furnace, so that a man could work a wire-drawing machine within 2ft. of a furnace which was annealing the wire at a temperature of 800 deg. or 900 deg., and yet not feel the heat.

Mr. A. Glynne Lobley discussed the merits of the rotating arc type of furnace, and said that the Watson furnace, which was of English design, had certain outstanding advantages over the Detroit. Whereas the latter was a single-phase furnace—which fact might lead to trouble with the power supply authorities—the Watson could be made three-phase, the electrical arrangement was out of the way of the operator, and there was very little fear of breaking electrodes. Some years ago he had built a furnace in which carborundum troughs were used, with granular carbon as the resister, for the purpose of melting aluminium electrically in bulk, and it gave excellent results. The furnace, which held about 15 cwt. of metal, had two longitudinal troughs, the metal being charged at one end and poured from the other by tilting the whole furnace. It cost much less to run than the producer gas furnace it had supplanted, and the losses were reduced enormously. He also referred to a crucible furnace he had used, heated by external nickel-chromium resisters, for melting aluminium alloys in small quantities for die casting, in which case also the cost was less than that of the gas furnace which it had supplanted. The crucible held 60 lb. It was described in the "Proceedings" of the American Electro-technical Society, Vol. 42. With regard to annealing furnaces, he said that in addition to the "Efco" type with the shielded resisters—in which the resisters ran through slots in the refractory—there were others built in this country. In one type the resisters, consisting of nickel-chromium strip, were held in metal supports in such a way that there was no shielding at all, so that hot spots were avoided, and it was possible in that way to employ a higher wattage per square inch in the resister. After pointing to the opportunities for recuperation which electric furnaces offered, he discussed the possibilities of high-frequency current for heat treatment, and mentioned a patented method in which currents of extremely high frequency were applied to bring about surface treatment without raising the whole of the material to the required temperature.

The necessity for the supply of cheap electric current for the purpose of encouraging the use of electric furnaces was emphasised by Dr. Max Haas, of Germany.

Mr. H. H. Hayes gave figures relating to the performance of an Ajax-Wyatt furnace in the Midlands running on continuous twelve-hour shifts, the furnace being shut down from twelve noon on Saturday until 6 a.m. on Monday. The figures, taken from a typical week's run, were as follows:—

Metal charge, 24·6 tons.
Metal poured as ingots, 24·1 tons.
Metal poured as ingots, 98·5 per cent.
Weight of splashings put back into furnace for remelting, 0·602 per cent. of weight of metal charged.
Weight of skimmings and chippings put back into furnace after being washed, 1·91 per cent. of weight of metal charged
Hours running, 168·0
Hours melting, 126·0
Hours stand-by, 42·0
Units to melt per ton of metal charged, 240.
Units to melt per ton of metal poured as ingots, 243.
Units used during stand-by, 400.
Units used during stand-by to total units, 6·37 per cent.
Total units to melt per ton of metal charged, 256.
Total units to melt per ton poured as ingots, 260.
Total metal irrevocably lost, 2·5 per cent.

The figures of units to melt per ton varied considerably. Scrap losses also varied considerably, and when using about 30 per cent. of virgin material in the charge, the remainder being fairly heavy scrap, they averaged 2·5 per cent. These figures he compared with those obtained from a furnace of the same type, except that it ran on 25 cycles, whereas the first furnace ran on 50 cycles. On a run of 1000 tons the average loss was 2·54 per cent. In no instance was more than 10 per cent. of virgin metal used in the charge, the rest being fairly bulky scrap. The average weekly output of the furnace, which ran continuously, was 35·6 tons; the energy input was 65 kilowatts at 400 volts. At times, when labour was good, the furnace had actually melted with a consumption of 218 units per ton, the output under those conditions being 42½ tons per week. When running on an output of from 35 to 38 tons per week the energy consumed was 230 units per ton. The furnace had melted and poured 600 lb. per hour without any difficulty. Commenting on the failure of refractory makers in this country to provide the Ajax-Wyatt lining material, which he regarded as a disgrace, he said the material had been analysed and sieved, and sent round to refractory makers in test tubes, with the request that they should imitate it, "but they darned well could not do that." Finally, he urged that annealing furnaces should be designed in accordance with the shape of the articles to be treated, and said that if they were built in the shape of a narrow or shallow trough or tunnel through which straight strips could be pushed or conveyed by conveyor chains, their efficiency would be materially increased.

Mr. Otto Frick discoursed upon the possibilities in connection with the use of the induction furnace, which, he said, had not been fully realised, and he charged metallurgists with having been asleep in this matter. In regard to refractories, he said that six months' working of a new design of induction furnace for non-ferrous metals warranted the conviction that a lining for use in the melting of those metals would shortly be forthcoming. For brass the problem had already been solved, and the lining of a 120-kilowatt brass furnace in a Swedish factory gave promise of a very long life. The misunderstanding with regard to the use of the induction furnace for non ferrous melting, which was due to lack of knowledge, was as common amongst makers as amongst users. He described in detail a Frick furnace in Sweden, operated at 130 kilowatts, which gave perfect satisfaction in all respects, producing 12 tons of brass of absolutely uniform analysis in twenty-four hours, quick transfer of heat and reliable alloying being secured simply by utilising the rotary movement of the metal in the heating channel.

Dr. Walter Rosenhain was in sympathy with the complaint as to lack of advancement in regard to refractories, and said it seemed to him that the refractories problem was a bugbear which was being allowed to stand in the way of the development of furnaces as it certainly should not do. A reasonable application of modern research methods should not fail to produce the desired results. The high-frequency Ajax-Northrup type of furnace he considered to be in many respects the most important laboratory research tool that had been put into the hands of the metallurgist during at least fifty years, and the degree of purity obtained with other furnaces was not remotely comparable with what could be done with the high-frequency furnace. There were difficulties, however, when it came to its applicability to industrial uses, one being the temperature gradient from the hot metal to the cold inductor coil, two great disadvantages arising from that being loss of heat and intense strain on the refractory. In his laboratory he expected the crucible to crack, and it invariably did. The proposition of annealing and heat treating by electricity was most attractive, and to generate the heat within the strip seemed to be absolutely ideal. With regard to heat insulation, when a furnace was running continuously, the insulation should be good, because it meant so much saving of heat; but when the furnace was used discontinuously the problem was different. A paper published in Germany had shown that one could increase very much the overall efficiency of a furnace doing successive heats by cutting down the insulation, it being a question whether the loss of heat due to cooling during the run was a bigger factor than the heating up of the insulation each time. Finally, he pointed out that the advantages of electric working generally were much greater than would appear from a mere consideration of the costs involved; anything which would improve the conditions for the workers and increase their efficiency and their willingness to work was to be welcomed.

Mr. Campbell, replying to the discussion, said that the figures to which Dr. Brownsdon had taken exception were obtained from a furnace working under favourable conditions, as stated in the paper, but they were actual records. As to the use of electric furnaces for annealing, he said there were a considerable number in operation in this country, some of them being employed on the continuous annealing of wire for submarine cables, where it was necessary to work within very close limits, and they were giving complete satisfaction. The whole of the wire in the Pacific cable—the longest in the world—was annealed electrically. Other furnaces of large dimensions had been erected for the heat treatment of aluminium for the Admiralty, and for various other operations of that sort. In reply to Mr. Barclay, he said he considered that we should be able to refine fairly efficiently, if not very efficiently, with the high-frequency furnace. He foreshadowed great improvements in the refractory linings in the near future, but pointed out that it was necessary to be absolutely certain of the data before stating that a certain lining was suitable for a certain metal. To Dr. Rosenhain he replied that there was no trouble with the plumbago crucible in the high-frequency furnace, but carbon-free crucibles were a problem.

The Leipzig Fair.

No. II.*

THE Technical Fair in its present form dates from 1918, when it was decided to concentrate on one spot exhibits of a technical nature, which had previously been distributed amongst numerous buildings in the town. A site of about 100 acres was obtained on the outskirts of the town, and laid out as a permanent exhibition ground. The buildings comprise fifteen halls of various sizes, some of them of majestic proportions and all laid out with a view both to convenience and to architectural effect. There are other halls provided for in the plan, and the whole, when complete, will constitute an unrivalled setting for an annual exhibition equally unrivalled. The determination of German manufacturers to support the Technical Fair was shown by the remarks made by Herr Karl Lange, the director of the Verein Deutscher Maschinenbauanstalten, in an address of welcome to the representatives of the Press. Speaking on behalf of the extremely powerful organisation which he represented, he said that it had been decided by the members of the association to refrain from showing at other Fairs and exhibitions, and to combine with the Leipzig authorities to make the Leipzig Fair an occasion for an outstanding display of their products. A central information bureau, conducted by the leading machine-building organisations, would see that the visitors to the Fair were furnished with reliable information on technical and other questions. He also hoped to see foreign technical products in larger numbers at Leipzig, so that a fair comparison might be made. Herr Lange also gave some interesting figures relating to the German machinery industry. He said that before the war Germany was the greatest exporter of machinery in the world. For the year 1924, the first year of a stabilised currency, she had slipped back to the third place. By the spring of 1926 she had overtaken the British exports and had reached the second place. The three great manufacturing countries of the world, namely, the United States, England and Germany together produced 80 per cent. of the machinery exported. During the first quarter of the year 1924, Germany's proportion was only 20·4 per cent. By the autumn of 1926 it had reached 27 per cent., and was now greater still. Another interesting fact was that, whereas, before the war German machinery exports to America were only equal to half the imports of American machines, since the year 1924 there was actually a balance in favour of Germany. Trade generally, he was certain, would be much improved if countries would lower their customs barriers and allow of freer import and export.

The importance of Herr Lange's speech did not lie either in his hopes for freer trade, nor even in his statistics, as the exact meaning of the latter was not very clear. The point that should be pondered over by British engineering manufacturers is the support which their German rivals are giving to their great national Fair. No one who has seen the Fair at Leipzig can doubt for a moment what an enormous asset such an exhibition is to German trade. The impression made by the machine-tool section alone is ineffaceable, and the foreign buyer, even if he is aware that once every few years some British machine tools may be seen at Olympia, can hardly be blamed for believing that in comparison with the German tool industry, the British industry is not worth consideration. It is almost the same with other engineering products. For a buyer to see as many and as great a variety of products as can be examined in a single visit to Leipzig, he would have to visit a series of small exhibitions in England, spread over a term of years. The time has gone by when the Leipzig Fair was a matter of toys and trinkets and fancy goods. These are still there, acres of them, but the Technical Fair has arisen since the war, and has become an institution for the manufacturers of other countries to reckon with. The Technical Fair, as we have said, was housed in fifteen halls, and there were, in addition, a very large number of machines in the open air. The halls are not numbered consecutively, as the numbers allocated to those not yet built are naturally wanting. Although articles of a kind were fairly well segregated in their appropriate halls, the classification was far from perfect, and so instead of discussing groups of products we will deal briefly with the contents of the various halls in turn.

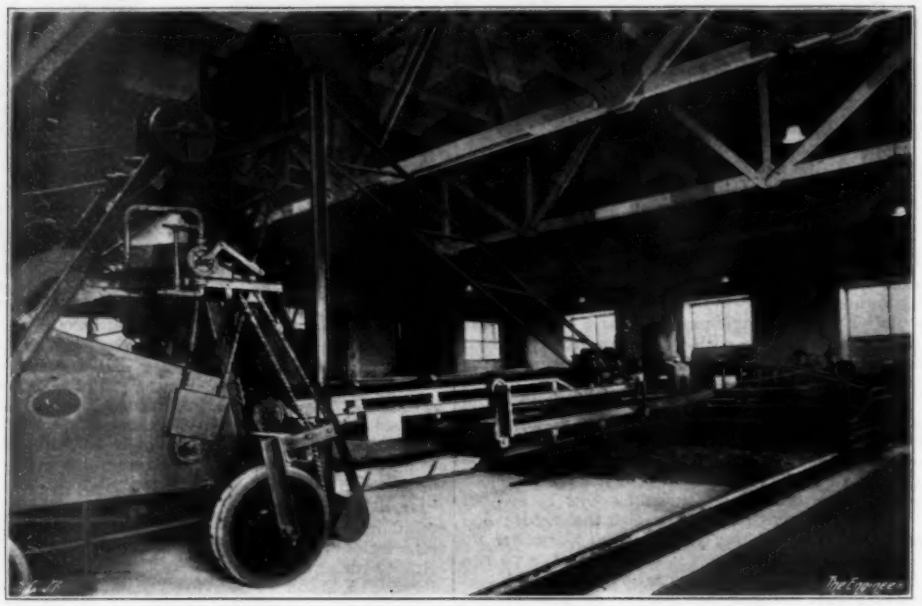


FIG. 1—ROAD-MAKING MACHINE—VÖGELE

HALLS 1 TO 8.

Halls No. 1, 2 and 3 were occupied, on the whole, with exhibits relating to the building and allied trades. Hall No. 1 was devoted chiefly to such articles as bricks, tiles, artificial stone, stained glass, tombstones, &c. Hall No. 2 contained brick and tile making machinery and concrete mixers, while Hall No. 3 housed a collection of stoves and cooking ranges, with almost nothing besides. By far the most imposing exhibit in any of these halls was a concrete road-making machine of the Millar type, shown by Joseph Vögele, of Mannheim. The whole machine, which was exhibited in Hall 2, consisted of two parts. In front—Fig. 1—there was a concrete mixer with a capacity of three-quarters of a cubic yard at a time. At some distance behind the concrete mixer came the second part of the machine, which was connected to the first part by a telescopic belt conveyor. The second part of the machine was the full width of a road 6 m. wide. It consisted of a carriage carrying a transverse trough, into which the concrete was delivered. On the carriage was an electric motor, which drove an endless rope to which the conveyor end was attached, the motion of the rope causing the conveyor to traverse from end to end of the trough, thus delivering the concrete uniformly along the trough. The carriage was supported by wheels at each end running on rails laid at the side of the road, and it could be caused to advance or move backward by the motor which drove the wheels. Behind the carriage, and attached to it by pin joints was a framing which served as a carrier for a number of rollers. These latter were arranged in two rows, the front row containing four, and the latter five. Altogether they covered the full width of the road, and the first four were driven by the motor referred to, and thus in conjunction with the side wheels took their share in propelling the machine. A reference to Figs. 1 and 2 will help to give an idea of the construction. In operation the trough is filled with concrete by the side to side movement of the end of the conveyor. The hind part of the machine then advances, depositing the concrete in the roadway and subjecting it to the action of the rollers. The rollers pass and re-pass several times to give the necessary consolidation, the conveyor telescoping to allow of the fore and aft travel of the carriage. Adjustment of the rollers on the frame is provided, so as to allow of any desired camber being given to the surface. When a section of roadway has been finished, the rails are taken up and relaid ahead, ready for the next section. An 8 H.P. motor drives the carriage and a 15 H.P. motor serves to operate and propel the concrete mixer. The machine will make and lay 15 cubic metres of concrete per hour, and will finish 150 m. of road, 6 m. wide in a day.

Halls Nos. 4 and 5 contained little of engineering interest. The former building held little else than baths, lavatory fittings, washing machines and laundry appliances, while the latter was devoted to a really enormous display of electrical fittings, accessories and wireless telephone apparatus, even a cursory inspection of which would have required a day or more, if every stand was to be visited. Hall No. 6 had contents of a very mixed nature, ranging from caterpillar tractors to bottle-labelling machines, but the general impression it gave was that of a collection of apparatus mostly for use by butchers, hotels, &c. Machines for making the sausages which fill so large a part in the German domestic economy, were to be seen in abundance, as well as a number of small refrigerating appliances. Flour milling and dressing machinery was also well represented. The first British exhibit which we noticed in any of the Halls so far mentioned was found in Hall No. 6. It was a display of machines for packing and wrapping such articles as caramels, cigarettes, &c., made by Rose Brothers, Ltd., of Gainsborough. The machines were shown at work, and appeared to arouse considerable interest.

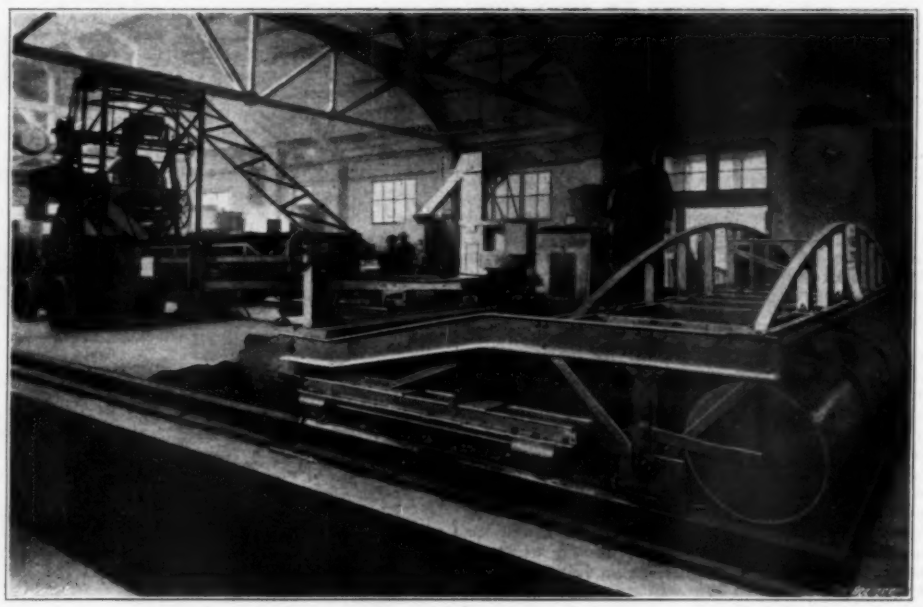


FIG. 2—ROAD-MAKING MACHINE—VÖGELE

Hall No. 7, which is of very large expanse, was stated in one of the official publications to contain heavy commercial motor vehicles; but it contained nothing of the sort. Except for a restaurant at one end, it was given over to a vast and dreary exhibition of plans and pictures relative to town planning and domestic architecture in nearly all the countries of the world. England had its section, which contained photographs of "County Council" houses, though, fortunately for the reputation of British architecture, only a few of the best were illustrated. The next Hall,

* No. I. appeared March 11th.

No. 8, contained miscellaneous engineering exhibits. About half a dozen types of motor cars were shown, but, except for one German vehicle, all the rest seemed to be of the more generally known American makes. The German automobile manufacturers hold their own exhibitions, and have refrained, so far, from taking advantage of the Leipzig Fair. In the same hall were to be seen a good many textile machines, all, of course, in operation. They were largely of Swiss manufacture, and included Jacquard looms, ring-spinning frames, winding machines, and several silk ribbon weaving machines. Other engineering exhibits included a model aerial ropeway by Bleichert, rubber mixing machines, hydraulic pumps, printing and box-making machines, and various kinds of weighing machines.

HALL 9.

With Hall 9 we come to the great and outstanding feature of the technical Fair, namely, the Exhibition of the German Association of Machine Tool Manufacturers. The magnificent hall, the external appearance of which was illustrated in our issue of March 12th, 1926, belongs to the Association, and this year once again it housed what is probably the finest collection of machine tools ever assembled in one place, all either actually working or able to be set in motion instantly if anyone showed interest in them. A glance at the interior view of the hall which we reproduce in Fig. 3 will do more to give an idea of the exhibition than any amount of description. There were 216 different firms exhibiting, and a special catalogue of 120 pages, issued in an English as well as in a German edition, had been drawn up by the Association. In our account of the Leipzig Fair of last year, we mentioned the arrangements for providing technical and other information to interested engineers, the assistance given in finding the exhibitors of machines of any particular types, the courtesy and kindliness of the technical representatives of the Association, and, in general, the perfect organisation of the whole business. We can only repeat what we said then, for the same remarks are equally applicable on this occasion. It seems invidious to pick out the exhibits of particular firms for special mention, but it may be said again that the most striking machines, from the point of view of power and magnitude, are shown by Messrs. Schiess-Defries, of Düsseldorf, and Messrs. Henry Pels, of Berlin. The principal exhibit on the stand of Messrs. Schiess-Defries is a huge horizontal boring mill constructed to the order of Messrs. Brown, Boveri and Co., for boring cylinders. The machine, which is shown in motion, has a travelling column and a vertically adjustable boring bar. The boring bar is 600 mm. diameter. It carries heads capable of boring work up to 4 m. diameter and 14·5 m. long, and facing to 5·600 m. diameter. Electric push-button control is fitted to all motions. The weight of the machine is about 220 tons. Its general appearance will be gathered from the view of the hall reproduced in Fig. 4, in which it appears in the foreground. Another large machine on the same stand was a

FIG. 3—THE MACHINE TOOL HALL

FIG. 4—HORIZONTAL BORING MACHINE—SCHIESS-DEFRIES

heavy double-bed centre lathe. The height of centres of this machine is 900 mm., and work up to 8000 mm. long can be taken between centres. The back bed carries one tool post, two steadies and the loose headstock, while two more tool posts are on the front bed. As in the former case, the machine is fitted with universal push-button control. The most striking exhibit on the stand of Messrs. Henry Pels was a shearing machine capable of cutting off steel billets up to 7in. square. It was shown doing this work, so that there should be no doubt about its capacity. Last year a machine of the same type, but capable of cutting off 8in. square billets, was shown by Messrs. Pels. This machine, which has since been sold to one of the large German steel works, was illustrated in our issue of July 30th, 1926. Among other heavy machines, we may mention a gear-hobbing machine, shown by Messrs. Schuchardt and Schütte, hobbing a cast iron spur wheel 3in. pitch with forty-eight teeth about 18in. broad on the face. The hob had inserted cutters. A somewhat smaller machine, using a solid hob, was shown cutting a single helical gear. A motor-driven air hammer, said to be the largest of its kind in the world, was to be seen on the stand of the Eumuco A.G. für Maschinenbau, of Schlebusch-Manfort. It had a falling weight of 2 tons. There were also several powerful railway wheel lathes on view, Messrs. Wilhelm Hegenscheidt, of Ratibor, showing one capable of turning up forty-eight tires in an eight-hour day. This machine also had push-button control, which is becoming quite a common feature of large modern machine tools.

HALL NO. 10.

The next hall in numerical order is No. 10, the "Haus der Elektro-technik." As no heavy machinery of any kind was shown, the display gave a very inadequate idea of the German electrical industry. The principal stands in the hall were those of the Allgemeine Elektricitäts Gesellschaft and of Messrs. Siemens and Halske and Siemens-Schuckertwerke, which between them took up the greater part of the centre of the hall. The Allgemeine Company showed an apparatus designed for the automatic control of boilers working with powdered fuel, the apparatus regulating fuel and air supply in accordance with the load so as to maintain a constant percentage of CO_2 in the flue gases. The mechanism is much too complicated to permit of a brief description, but the principle is as follows. A greater demand for steam by the turbine leads to a greater differential drop in pressure in the steam pipe. This drop in pressure, acting on a diaphragm, brings about an increased speed of the coal feeders and a movement of the dampers to give an increased air supply. The damper mechanism is also under the partial control of a CO_2 indicator in such a way that if the needle of the latter moves away from the desired point on the scale the air supply is increased or diminished until the correct conditions are re-established. A group of electric welding machines was shown by Messrs. Siemens-Schuckert, one being arranged for automatically welding metal on to the worn rims of wheels to enable a new tread to be formed. The only steam turbine plant in the hall, and we believe in the whole of the Technical Fair, was on the stand of the Maffei-Schwartzkopff Werke. Here were two little turbine-driven pumps and a small turbine-driven lighting set. A sectioned example of another turbine pump showed the turbine to be of the single-stage impulse type with three running rows of blades and the pump to have two impellers in series. Of purely electrical apparatus, perhaps the most imposing was a three-phase circuit breaker for 100,000 volts. Several firms showed ironclad switchgear, but it all seemed to lack the solidity of the English designs. Indeed there is little doubt that as regards switchgear English manufacturers are well ahead of their German rivals, the lead they gained by the introduction of ironclad gear having never been lost. Electric motors, fittings, domestic appliances and wireless apparatus were plentifully represented, but nothing appeared to call for special remark.

Street Lighting.

"THE Problems of Public Lighting by Electricity" was the title of a recent paper read before the Institution of Electrical Engineers by Lieut.-Commander Haydn T. Harrison, the well-known authority on illumination. That the lighting of many public thoroughfares in this country leaves much to be desired most people will agree, and as the paper shows, very little advance has been made within recent years, the conditions to-day being very similar to those which existed in 1913. To a large extent the safety of the public still has to be provided for by the motor vehicle headlights and the protection of property by the policeman's lantern, the main obstacle to improvement generally being that of cost. The illumination of streets of all classes can, however, be raised to the standard demanded by civilisation of to-day without incurring an expenditure that will materially increase the rates. The demands of modern civilisation, the author contends, are such that the height, spacing and position of light sources should be re-arranged so as to avoid the use of very brilliant light sources and to reduce obstructions to vehicle and pedestrian traffic, which are liable to endanger the public. The scheme advocated is that of centrally suspending the light sources at frequent intervals by means of span wires, which, in order to simplify control and maintenance, should support the conductors. On account of their light weight and the small amount of attention they require, modern gas-filled electric lamps lend themselves very readily to this system of

lighting, which has been adopted with marked success in the City of London and elsewhere. As Mr. F. Bailey, the chief engineer of the City of London Electric Light Company, remarked during the course of the discussion, that the City lighting is generally admitted to be good and the central suspension of the lamps over the streets has proved to be the best method of providing that lighting. There are, of course, some who contend that to put more wires over the streets would be a retrograde step. Practically every electrical scheme that demands overhead wires meets with a certain amount of opposition, even if it can be shown that very material benefits will result from their use. In the present case there appears to be no question that where good street lighting is essential and when, as in most cases, expense has to be taken into account, centrally suspended lighting units have much to recommend them. Apart from the question of initial expense, standards at the roadside do not provide such efficient illumination as the suspension system provides, not to mention the fact that standards are a nuisance to vehicle and pedestrian traffic and are liable to be knocked down.

Although the installation dates back from 1911, the main streets of the City of London afford one of the best examples in this country of high-class street lighting. Both the gas and the electric lighting units are centrally suspended from span wires attached to the buildings at a height of 27ft. 6in., whilst in a few cases where the width of the streets permitted the lamps are mounted on central columns at a height of 25ft. 6in. Apart from Cheapside, which is regarded as a shopping centre and where the lamp spacing has been reduced to 95ft., the spacing averages 125ft. The original long-burning flame arc lamps with a special dioptric globe for increasing the candle-power are in use; the minimum horizontal illumination in the case of Cheapside approaches 1 foot-candle with a consumption of approximately 5 watts per linear foot. Other examples of the suspension system of lighting are to be found at Manchester, in Oxford-street, and Baker-street, London, and in the Westminster district near Charing Cross, where in certain parts the minimum illumination is said to reach 2·4 foot-candles. There are also examples of the suspension system in cities such as Glasgow, Newcastle, &c., all of which serve to emphasise that the best results are obtained by means of centrally arranged lighting units; that modern traffic conditions, combined with narrow streets, make it advisable to reduce obstructions by dispensing with standards, and that further increase in the brilliancy of light sources is inadvisable unless the height is considerably increased. That difficulties are likely to be met with in the direction of obtaining permission for attaching fixings to privately owned property is an argument that is sometimes advanced by those who are opposed to the suspension system, notwithstanding that experience indicates that opposition of this nature is seldom, if ever, met with in shopping districts where good lighting is beneficial to trade; indeed, it is said that few cases will be found in which owners of buildings would not prefer a small fixing on the wall to a street standard extending upward from the ground. As it has been proved beyond doubt that the number of street accidents is reduced and the safety of the public increased by the removal of street obstructions, there ought not to be great difficulty in the way of obtaining parliamentary powers governing the matter of attaching fixings to privately owned property. The lighting of less important thoroughfares such as side streets, residential streets, roads used for traffic, country town and suburban districts, and numerous slums which exist in all large towns and cities is obviously a matter of paramount importance because it affects the safety and to a large extent the welfare of the masses. Many who live in the slums and poor residential districts have never experienced the benefits of good illumination, or indeed any of the other benefits that electricity can provide. For a few pence on the lighting rate the slums might be much more brilliantly illuminated and the lives of those who live in them made more congenial. Side streets, lanes, alleys and slums can be dealt with on the same lines as those suggested for the better streets, because they are generally narrower and the buildings are eminently suitable for supporting the necessary fixings. Streets and roads forming the middle-class residential districts and suburbs are, however, more difficult to deal with because the buildings are set back from the road, which is often lined with trees. While in newly developed countries such as America and on the Continent, where electricity is often distributed by means of overhead mains, the poles for supporting the cables also carry the street lighting fittings, in this country special cast iron standards are used, the spacing of which is altogether too wide. The usual practice when converting from gas to electric lighting has been to replace the gas lamps by electric lamps either in the existing lanterns or on swan-necked brackets, but, in the opinion of Commander Harrison, if the existing lamp-posts and lanterns must be used, it is imperative in the majority of districts that their number should be doubled in order to reduce the spacing to a reasonable limit, and considering the low height, the most powerful light sources permissible should be introduced.

High roads, arterial roads, and those used by modern high-speed traffic through rural districts where a scattered population exists require consideration on account of the danger which they represent to the public. The headlights used on motor cars are unsatisfactory for various well-known reasons with which we need not deal, and if the author's scheme of lighting with fixed projectors along the roadside were adopted many would be thankful. Briefly, it is proposed that high roads and arterial roads passing through populated districts and used by motor traffic should be illuminated by means of highly concentrated light sources similar to motor car headlights, but fixed at a considerable height so as to give the required vertical illumination advocated by automobile authorities. There are many public lighting problems with which the paper does not deal, such, for example, as the lighting of open spaces, bridges, and so forth; but on the whole the author covers the main branches of the subject remarkably well. That adequate and suitable illumination is now a matter that demands the closest attention there can be no doubt. No one recognises better than the electrical engineer how imperfect many of the existing lighting systems are or how badly they need improving. Commander Harrison's paper, together with another paper on "Illuminating Engineering" read on the same evening by Mr. W. T. Walsh, and the outlining on that occasion by Mr. C. C. Patterson of the scope of the British Standards Association's draft specification for street lighting, all serve to indicate that electrical engineers are alive to the fact that much important work remains to be done, and there is no doubt that once the public authorities are made to realise that drastic alterations are essential, the gloomy and dismal appearance of many of our thoroughfares will quickly be removed.

DIESEL ENGINE USERS ASSOCIATION.

At the March meeting of the Diesel Users Association, which was held on Friday last, March 11th, a paper was read by Mr. P. A. Holliday, on the subject of "High-Revolution Oil Engines." In introducing his subject the author referred to the satisfactory results which had been obtained with high-speed ex-German submarine engines at the electric power stations of the Southend-on-Sea Corporation. He then went on to say that he found it difficult to determine the source of prejudice which undoubtedly existed in some quarters against high-revolution engines running on heavy fuel oil. A more generous attitude was adopted towards the petrol or paraffin motor. If revolutions, particularly those of the single-acting four-cycle engine, were kept to the old figures, what progress, he would ask, could be made. The four-cycle double-acting engine offered possibilities for increasing the output from any given size of cylinder, but it failed to justify its adoption except for large powers. Moreover, with the necessary addition of a separate crosshead, the weight of the reciprocating parts was increased, and with higher inertia forces the way to increasing the revolutions was barred. In the paper attention was also directed to the four-cycle single-acting engine and the possibilities it afforded of increased revolutions. Engines of this type had already been built for work on the Canadian railways, and both in America and on the Continent light weight engines of the four-stroke cycle type had been developed. Mr. Holliday then reviewed the possibilities of progress in the two directions, for electric generating sets, for power station work, and for aboard ship, instancing in the case of ship's auxiliary generating sets the increasing size of the units compared with the propelling machinery. Detailed drawings and particulars were given by the author of the construction and performance of a 600 brake horse-power six-cylinder Bellis and Morcom four-cylinder oil engine, designed to develop its full output at a normal speed of 350 revolutions per minute. The engine has a cylinder bore of 15¼in. with a piston stroke of 17in. with a mean piston speed of 955ft. per minute. It was described and illustrated in THE ENGINEER of November 12th, 1926. Although it has not yet been determined to what extent it will be possible to carry this design of high-revolution engine to higher powers, Mr. Holliday regards 600 brake horse-power as by no means a limiting figure. A six-cylinder engine designed to develop 1200 brake horse-power at 275 revolutions would, he thinks, present no difficulties worthy of mention, several sets of 1150 brake horse-power having been in successful operation at that speed for a number of years at Southend-on-Sea.

BUENOS AIRES PORT WORKS.

ADVICES from Buenos Aires reports that a ministerial decree has announced the immediate resumption, by Government engineers, of work on the New Port at that city, which has been in progress on and off since the year 1916, but has continually been interrupted. The sum of 20,000,000 dollars (gold) has already been spent on the scheme, and, in the opinion of the Department of Navigation and Ports, a further outlay of at least 15,000,000 dollars (gold) will be necessary before completion can be attained. No adequate return on the expenditure is possible until the extensions can be utilised to the full.

The dredging of the second and third docks has been finished with the exception of removing the temporary dams at the entrances to each of these docks from the new passage channel, but the completion of the sheds, depôts and general equipment is still awaited. The fourth dock, completed several years ago, with its access channel from the new ante-port, has still to be put into public service and grain elevators and general equipment have yet to be provided.

The necessity for the four basins being in operation as speedily as possible is generally recognised, and the Government is being pressed from every side to complete the works at all costs. It has therefore been decided to proceed with the last part of the dredging, although it is likely to prove costly. Three and a-half million paper pesos will be devoted to the provision of the two units, and a complete dredging train will be provided. One portion will be employed for the deepening of the existing channel where it crosses the bar off Punto Indio; the other, electrically operated, will work on the inside ports and confined spaces.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

USE AND ECONOMY OF HIGH-PRESSURE STEAM.

SIR,—May I ask you please to correct a small error which has crept into your report of the meeting of the Institution of Mechanical Engineers, printed in your issue of February 25th. The figures I gave at the meeting were as follows:—

(1) Steam expanding direct through turbines with conditions—350 lb. per square inch gauge, 750 deg. Fah. total temperature and 29in. vacuum. The percentage thermal efficiency allowing for wetness correction in the turbine is 36·05 per cent. and relative value for comparison purposes is 100.

(2) Steam supplied at 350 lb. per square inch gauge, superheated to total temperature of 1000 deg. Fah. and cooled in a heat exchanger to 750 deg. Fah. before entering turbine and reheating the steam going to the low-pressure turbine up to 720 deg. Fah., and finally exhausting into 29in. vacuum. The percentage thermal efficiency allowing for wetness correction in the turbine is 38·48 per cent. and relative value is 106·75.

(3) Steam supplied direct to the turbine at 350 lb. per square inch gauge, with a total temperature of 1000 deg. Fah. and exhausting into a vacuum of 29in. The percentage thermal efficiency allowing for wetness correction in the turbine is 38·57 per cent., and the relative value 107·0.

(4) Steam supplied direct to the turbine at 850 lb. per square inch gauge, 750 deg. Fah. total temperature and exhausting into a vacuum of 29in. The percentage thermal efficiency allowing for wetness correction in the turbine is 38·48 per cent., and the relative value is 106·75.

These figures indicate that the cycle carried out in Mr. Samuelson's system of operation (Case 2) gives practically as good a thermal efficiency as the direct expansion of steam from 1000 deg. Fah. temperature at which it leaves the superheater (Case 3).

Furthermore, the thermal efficiency of this cycle (Case 2) is equivalent to the case where the steam at more than double the initial pressure (Case 4), and with a steam temperature equal to the entrance temperature to the steam admission chest in Case 2.

R. S. T. COLLINGHAM.

Rugby, March 9th.

THREE-CYLINDER LOCOMOTIVES.

SIR,—I was much interested in the letter of Mr. Dauncey in your issue of the 4th inst. (page 240), especially in the fifth and sixth paragraphs.

Soon after the invention of the "Richards Indicator" (which, was, I believe, the first indicator with a stiff spring and a multiplying motion for the pencil) Mr. Chas. T. Porter, an American engineer, wrote a treatise on that indicator, published in New York. The date of the third edition is 1874. Pages 183 to nearly the end of the book show by diagrams and calculations how, by properly proportioning the weights of the reciprocating parts of the engine to their speed, thereby taking advantage of their inertia, a good approximation to an even turning moment on the crank might be obtained, the initial steam pressure and point of cut-off, of course, being factors. On these lines Porter made a horizontal engine which ran with steadiness at such a speed as astonished the engineers of that day.

W. H. THORNBERY.

Birmingham, March 14th.

TAXES ON TRANSPORT.

SIR,—May I ask space in THE ENGINEER to suggest that the present is no time for further additions to charges on transport. No less a sum than £10,000,000 has been added to those charges for this year—as to £3,000,000 by new taxes upon motor transport and as to £7,000,000 by the increased railway rates which came into force in February last. These amounts, to which certain additions are inevitable in the course of passing on between buyers and sellers, are already proving of adverse effect upon trade, industry and employment. Taxation strangles trade. Members of Parliament should have impressed upon them the consternation of all business men who hear rumours of still further disturbances of the kind. The trade of the country wants a rest in these matters, particularly at a time when it is so necessary that our export trade be regained.

EDWARD S. SHRAPNELL-SMITH,
President,
Commercial Motor Users Association (Incorporated).

ELECTRIC TROLLEY BUS.—On Monday last a party of visitors travelled down to Ipswich, at the invitation of Ransomes, Sims and Jefferies, Ltd., to see the construction of motor-buses at the vehicle works of the company, and to take part in a demonstration run in a trolley bus from the works to Felixstowe and back. The special features of this bus are that it is provided with giant pneumatic tires on all four wheels, single in front and twin at the rear, and that very special attention has been paid to springing, and to the seating arrangements. The body is arranged with two saloons, between which is a wide central entrance with a low landing step. The floor of the vestibule is only 2ft. 4in. from the ground. The motor, which was made by the firm, is of the enclosed-ventilated series-wound traction type with interpoles and develops 50 B.H.P. on the B.E.S.A. specification. The controller is of an improved form, and has five series and one field shunting notches. A floating tubular propeller shaft of special steel carries the power to the back axle, which was forged from a single billet, and is of the basin type for receiving the differential gear. A worm-reducing gear is employed. Each driving wheel is fitted with two independent expanding brakes, one operated by hand and the other by foot. The body work was also made by Ransomes. The front saloon accommodates fourteen and the rear saloon seventeen passengers, whilst three more can be carried on the off side of the vestibule,

Railway Matters.

THE 1.15 a.m. newspaper train from King's Cross to Newcastle now carries passengers. They thereby arrive in the northern towns at a more convenient hour than when travelling by the 11.45 p.m. train.

THE Southern Railway Company has just done what has been very uncommon among railway companies of recent years—deposited a "late" Bill. Its main purpose is the widening of four bridges over public roads in Peckham.

As a result of the serious disaster to a motor vehicle at Naworth on August 30th last, the London and North-Eastern Company proposes to adopt the recommendations of Lieut.-Colonel Mount and to interlock the gates with the signals and provide a warning bell.

ACCORDING to a written answer by the Secretary to the Treasury to a question by Commander Bellairs, the total cost of the fifty completed locomotives built at Woolwich and of the uncompleted parts for fifty more was £1,339,580. The total amount realised was £281,500.

TRAFFIC on the Seven King's–Chigwell–Woodford line of the London and North-Eastern Railway has been seriously interfered with by the collapse, on the 8th inst., of the bridge carrying the Hainault-road over the railway at Chigwell Station. It is presumed that the slip was due to the recent heavy rains.

THE possible extension of the Great Northern, Brompton and Piccadilly tube railway northwards from Finsbury Park was referred to in the reports of the London and Home Counties Advisory Committee on London Traffic, reviewed in THE ENGINEER of December 10th last. It now appears that London Electric Railways has anticipated that possibility by buying the site for a station at Arnos-grove, Palmers Green. The Arnos-grove estate is about to be developed, and it was feared that when the station had to be built the cost of the land would be very much higher than at present.

OWING to the improved running that has resulted from the use of the "King Arthur" class of locomotives—and, we would add, the strengthened bridges that permit uniform speed to be maintained—the boat trains that leave Victoria at 9 a.m. and 2 p.m. for Folkestone, arrive there so much earlier than formerly that, starting on Monday last, the boats sail for Boulogne 10 minutes earlier than before. The arrival times in Paris are unchanged, and the up trains remain unaltered, so evidently the acceleration is for the purpose of having time in hand against possible delays.

UP and down lines, reserved solely for locomotives and empty stock, are being provided by the Great Western between Paddington and the engine shed and carriage sidings at Old Oak Common. On a busy day about 100 sets of empty carriages have to be worked into Paddington and about 90 in the reverse direction. Those are independent of the corresponding light engines to work, or which have worked, the trains. The work was started early last year, and it is hoped to complete it by the end of this year. A diagram of the lines was given as a supplement to the *Great Western Railway Magazine* for March.

THE Ministry of Transport railway statistics for December, recently issued as a Stationery Office publication, price 2s. 6d., show that the number of passenger journeys was 7·1 per cent. less than in December, 1925, and the receipts from passengers 5·5 per cent. less. The passenger traffic receipts were less by 4·8 per cent., but passenger train mileage was reduced by 1·7 per cent. The tonnage of coal, coke and patent fuel was 13 per cent. less, and was the main factor in a drop of 12·3 per cent. in the freight tonnage. The freight train receipts were, however, only 1·7 per cent. lower, and, moreover, there was a falling off of 4·2 per cent. in the freight train miles. Train movements were slower as the net ton-miles per engine hour were 381, as compared with 395.

ACCORDING to the Board of Trade returns, the value of the railway material exported during January last was as follows, the corresponding figures for 1926 and 1925 being shown in brackets:—Locomotives, £75,298 (£383,866, £372,793); rails, £38,227 (£188,288, £228,930); carriages, £217,923 (£131,064, £158,920); wagons, £168,269 (£385,338, £368,121); tires and axles, £25,916 (£22,507, £42,297); wheels and axles, £20,026 (£33,210, £58,555); chairs and metal sleepers, £8589 (£80,053, £26,425); miscellaneous permanent way, £90,368 (£85,962, £124,003); total permanent way, £209,953 (£432,492, £491,823). The weight of the rails exported was 1811 tons (23,816 tons, 24,566 tons), and of the chairs and metal sleepers, 865 tons (7959 tons, 1939 tons). Of the locomotives, those shipped to other countries in South America than the Argentine were to the value of £37,759, and to India £10,483. Of the rails sent overseas those for the Argentine were of the value of £22,410, to South Africa £3767, New Zealand £2176, and Australia £1636.

CABLE advices recently from Cape Town intimated that serious defects had been found in 24,000 steel rails, to the value of £200,000, imported from Belgium. Answering a question in the South African Parliament on March 7th, the Minister of Railways said that the inspection had not then been completed, but, out of 13,640 rails inspected, 3355 had been rejected. The accepted tender was 132s. per ton, as against 152s. to 172s. 6d. per ton from Germany and 164s. 6d. per ton from Great Britain. There has also been a serious report as to the splitting of the rails used in the Natal electrical zone, but particulars as to that are not yet available. The subject of purchases of railway material outside the Empire again came up in the House of Assembly last Friday on the debate on the Railway Appropriation Bill. According to *The Times* correspondent, Mr. Malan, the Minister of Railways, quoted figures showing the total railway purchases in Great Britain and abroad by the Union Government in the past two years. In 1925 goods valued at over £3,300,000 were purchased in Great Britain, and goods valued at £1,800,000 abroad. In 1926, when British industry was handicapped by the coal stoppage, goods valued at £2,400,000 were purchased in Great Britain and goods valued at £2,300,000 abroad. Thus more was purchased from Great Britain than from abroad, even in that troubled year.

Notes and Memoranda.

THE net tonnage of vessels that entered and cleared with cargo and in ballast at ports of the United Kingdom from and to other countries last year amounted to 82,278,000 tons and 82,608,000 tons respectively, as against 84,018,000 tons and 85,290,000 tons respectively in 1925.

THE total horse-power of engines in the spirit distilleries in Great Britain in 1924 amounted to 12,685, of which total about 20 per cent. was shown as in reserve or idle—not generally in use—during the year. In addition, electric motors driven by purchased electricity of an aggregate horse-power of 3022 were returned, about 18 per cent. being shown as in reserve or idle.

AT a recent meeting of the Joint Industrial Council for the Printing Trades of the United Kingdom, reference was made to the recent report issued by the Illumination Research Committee. Mr. Goodwin, joint secretary, pointed out that, according to the report, at least 20 foot-candles was needed, and few printing offices were at present lighted to that degree. Mr. Yates urged that information concerning lighting should be made available immediately for use in connection with new offices under construction. It was decided to obtain 200 copies of the report, and issue one copy to each member of the Council and two copies to each District Committee. Some discussion also took place on the choice of illumination photometers to enable the lighting conditions in works to be studied.

IN a paper read before the Junior Institution of Engineers recently, Mr. Wolstenholme dealt very thoroughly with the iron foundry cupola, and concluded with the remark that the efficiency of the most efficient cupola, stated as a percentage of the heat units used in melting the iron to the heat units present in the coke, was probably not more than 50 per cent., while the majority of cupolas probably had an efficiency of less than 20 per cent. Although much discussion had been given to the subject of recent years, he did not know of any prolonged research, and when it was remembered that the difference between 20 and 50 per cent. efficiency meant a saving of at least seven shillings per ton of metal melted, or probably eight or nine shillings per ton of castings produced, it would be recognised that the subject was one of considerable importance.

THE last ordinary meeting of the Institution of Electrical Engineers was preceded by a demonstration in the Common Room by Mr. Ll. B. Atkinson, of a very old electro-pneumatic lamp. It consists of a glass vessel wherein hydrogen gas is generated by the action of acid on zinc. On a lever being depressed, a jet of gas is liberated and simultaneously ignited by a spark from an electrophorus contained in the wood base of the instrument. The whole is housed within a decorated porcelain container, representing a "Temple of Venus," and is in an excellent state of preservation. The device was patented in 1807, and was made in Germany. It has been in the possession of Mr. Atkinson's family for over 100 years, and is an extremely rare specimen of its kind. Two papers were presented, and a discussion followed during which a draft B.E.S.A. specification for street lighting was outlined.

NORMAL air contains about 21 per cent. of oxygen. A candle or oil flame will not burn in atmospheres containing less than about 16½ per cent. oxygen, yet man is sufficiently adaptable to get along fairly well in 17 per cent. of oxygen. He will breathe a little faster and a little deeper. The effect is about the same as going from Pittsburgh to Denver, Colorado, with elevations of 630ft. to 5000ft. respectively. But most men cannot work in air with oxygen below 13 per cent., the point where an acetylene flame is extinguished by oxygen deficiency. No one should ever enter an atmosphere where an acetylene flame goes out without an oxygen-breathing apparatus or an air hose-mask. In an atmosphere containing between 10 and 13 per cent. oxygen men become dizzy, pant, have a rapid heart beat, and often suffer from headache; 8 to 10 per cent. usually produces unconsciousness and ultimately death.

IN spite of the rapid strides which have been made in the use of continuous wave telegraphy, especially regarding valve transmission, the simple spark transmitter has so far successfully withstood the invasion of the valve transmitter in ships' wireless equipment. From time to time, states a writer in the *Electrical Times*, additional improvements have been made in ordinary spark transmission, such as the introduction of the synchronous spark, the use of the quenched spark, &c., but from the purely electrical point of view very little change has occurred since the inception of spark wireless telegraphy. But signs are not wanting to show that at last the more modern methods of generating wireless waves are beginning to oust the spark system of telegraphy, even for ship to ship and ship to shore communication. One of the greatest difficulties in this business of getting rid of spark telegraphy was the type of receiver necessary for continuous wave telegraphy.

AT the request of the New York State Bridge and Tunnel Commission, which desired information on the contamination of tunnel air by carbon monoxide in the exhaust gases of automobile engines, the United States Bureau of Mines made tests to obtain the necessary data for a ventilating system for the Holland vehicular tunnels under the Hudson River at New York City, now being constructed. The data obtained for these tunnels were applicable to the Liberty vehicular tunnels at Pittsburg, Penna., completed in 1924. Four parts of carbon monoxide in 10,000 parts of air were determined as the maximum concentration to which a person may be exposed for one hour without noticeable effect; or, if the concentration is increased from zero uniformly for one hour, the maximum concentration tolerable is six parts per 10,000, averaging three parts per hour. An apparatus that would automatically determine and record such low concentrations of carbon monoxide was developed by the Bureau. The recorder is equipped with a bell to warn attendants in the fan house should the CO in its section at any time exceed four parts in 10,000. Further, the recorder can effect considerable saving in power at the fan house if the volume of air is reduced when the CO is low. The recorder has proved to be the most sensitive instrument hitherto known for determining carbon monoxide. Details of it are given in Technical Paper 355, recently issued by the Bureau.

Miscellanea.

THE Spanish Cabinet is reported to have approved plans for making Seville a port accessible to large vessels. The necessary works, which, it is stated, are to be finished in five years, will cost some 40,000,000 pesetas.

THE Executive Power of Argentina has, according to *La Nacion*, sanctioned the plan of works submitted by the Direction of Navigation and Ports. The plan includes an expenditure of 12,979,868 dollars on the new port of Buenos Aires.

A NEW central electricity station has recently been completed in Ghent, the plant comprising two 10,000-kilowatt steam turbo generators. The old station, which has a capacity of 3000 kilowatts, is being converted into a transformer station.

THE *Prager Presse* learns that the Czechoslovak Ministry of Finance has prepared a Bill for the creation of a road fund which would be used for repairing roads in Czechoslovakia on a large scale with concrete or asphalt. As the application of the Bill depends on the realisation of administrative reform, the Bill will not be submitted for parliamentary discussion until the summer of this year.

A RUMANIAN company which will monopolise broadcasting and the manufacture of radio apparatus, and possibly telephone and telegraph apparatus is to be established. The International Radio Broadcasting Commission of Geneva has allotted a wave-length of 236·2 m. to Bucharest, says *Commerce Reports*, but the local director of radio communication has requested permission to use a wave-length of 400·5 m.

THE text of the Shannon Electricity Supply Bill has been issued. It provides for the distribution, control, and sale of Shannon current throughout the Free State, and proposes to establish a State monopoly. When the constructional work is finished the whole scheme will be handed over to a board consisting of not fewer than three, and not more than seven, members, of whom the chairman will be a whole-time official. This board will have power to acquire all existing electrical undertakings in the Free State, of which there are about ninety, including some twenty authorised concerns. Compensation will be paid at a rate to be arranged either by agreement or by arbitration, and the board will be required to take over all staffs on their existing contracts.

ACCORDING to the latest report of the National Federation of Iron and Steel Manufacturers, the number of furnaces in blast at the end of February was 162, an increase of 10 since the beginning of the month. At the end of April, 1926, 147 furnaces were in blast, and at the end of February, 1926, 146. Production of pig iron in February amounted to 567,900 tons, compared with 434,600 tons in January, 539,100 tons in April, 1926, and 502,000 tons in February, 1926. The production includes 194,600 tons of hematite, 187,700 tons of basic, 142,900 tons of foundry, and 17,500 tons of forge pig iron. The production of steel ingots and castings amounted to 819,100 tons, compared with 730,700 tons in January, 661,000 tons in April, 1926, and 703,800 tons in February, 1926.

FOLLOWING on the installation of the first 25,000-kilowatt turbo-alternator set, by the Metropolitan-Vickers Electrical Company, in the Lister Drive No.3 Power Station, which was officially opened in July last, the Liverpool Corporation has now placed another order with this company for the second 25,000-kilowatt set for this station. The contract includes a turbine and alternator similar to those of the first set, together with complete condensing plant and auxiliary apparatus. The set is for operation at 1500 revolutions per minute. The turbine will be of the two-cylinder type, the high-pressure and low-pressure cylinders being arranged in tandem. It is designed for a steam pressure of 275 lb. per square inch gauge, with steam superheated to 675 deg. Fah., and a vacuum of 27·6in. at full load. The condenser, which will be in a single shell, will be of the Metropolitan-Vickers Central Flow type. The auxiliaries include Metropolitan-Vickers steam-operated air ejectors of the two-stage type, with surface inter and after-coolers.

AT the forty-ninth annual general meeting of the Institute of Chemistry, held at 30, Russell-square, Professor G. G. Henderson, President of the Institute, remarked that there appeared to be some abatement of the enthusiasm for chemistry as a career which was noted immediately after the war, although the roll of membership had increased by 242 during the past year, to a total of more than 5200. At present the supply of chemists in Great Britain exceeds the demand. In October next the Institute will celebrate its jubilee, and a medal and prize have been established in honour of the first President, Sir Edward Frankland, who held office from 1877 until 1880; the award will be made to a registered student of the Institute for the best essay on a set subject of professional, as opposed to technical or purely chemical, importance. The subject for the first essay will be "The Importance of Chemistry to the Welfare of the People." Professor Arthur Smithells has been elected President of the Institute for the period of 1927-28.

IN spite of the general strike and the coal dispute, new records were established in practically every department of the telephone system. The details given in the current issue of the *Telegraph and Telephone Journal* show that the net increase in stations exceeded by nearly 5000 the growth in the previous year. The effects of the general strike were particularly felt in May and June, when the new orders showed a decline of 3404 on the previous year's totals, but in the latter six months of 1926 there was a marked recovery, the new stations added being 7025 in excess of the figure for the corresponding half-year of 1925. The total number of stations in the Post Office system on December 31st, 1926, was 1,477,000, an increase during the year of 119,092, or 8·8 per cent. The figures for Scotland are:—At December 31st, 1925, 129,314 stations; at December 31st, 1926, 137,949 stations, an increase of 8635, or 6·7 per cent. It is estimated that the number of effective calls originated during 1926 amounted to 1072 millions, an increase of 73 millions, or 7·3 per cent., over the total for 1925. Among the more important exchanges extended was Douglas (Glasgow).

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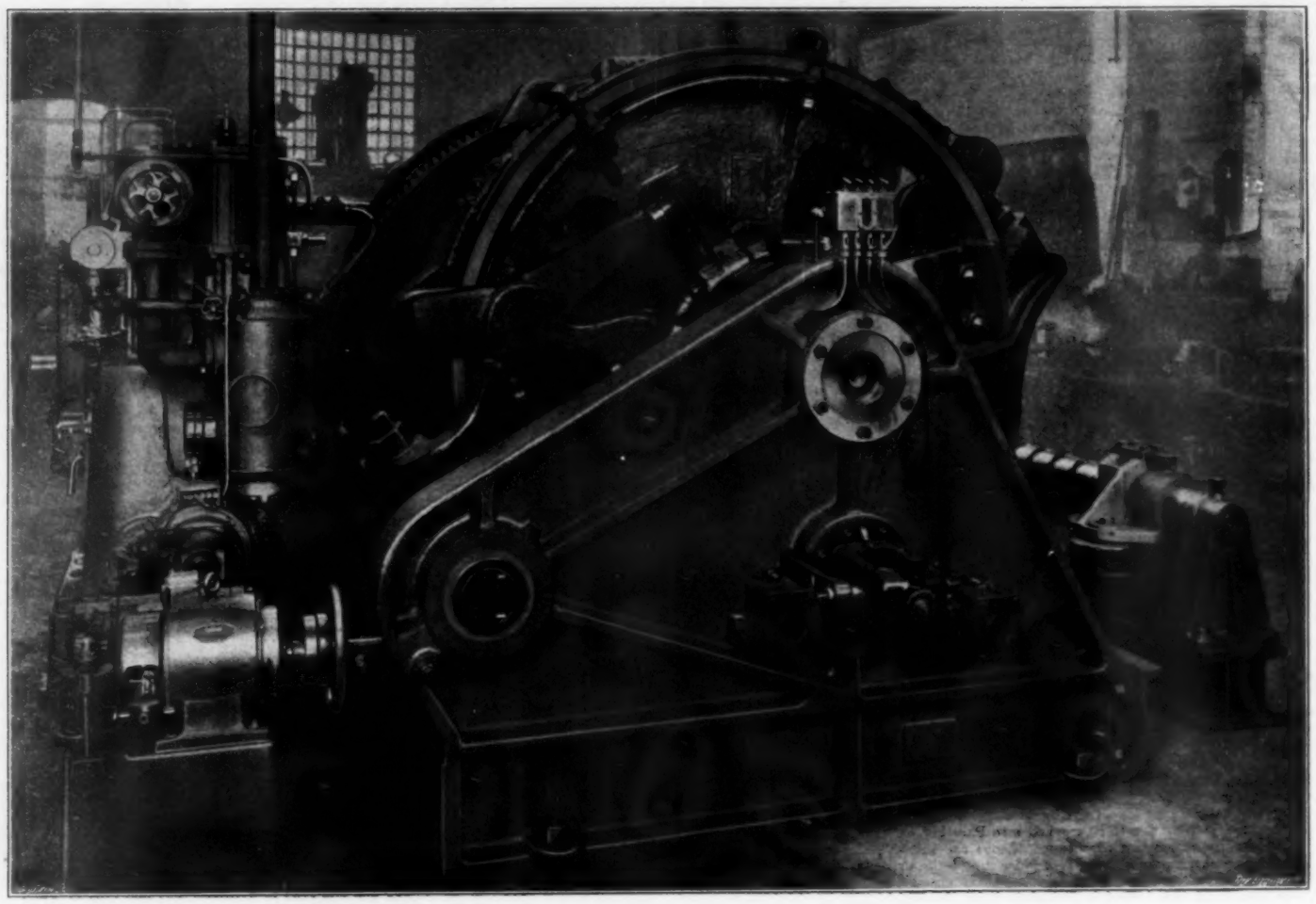

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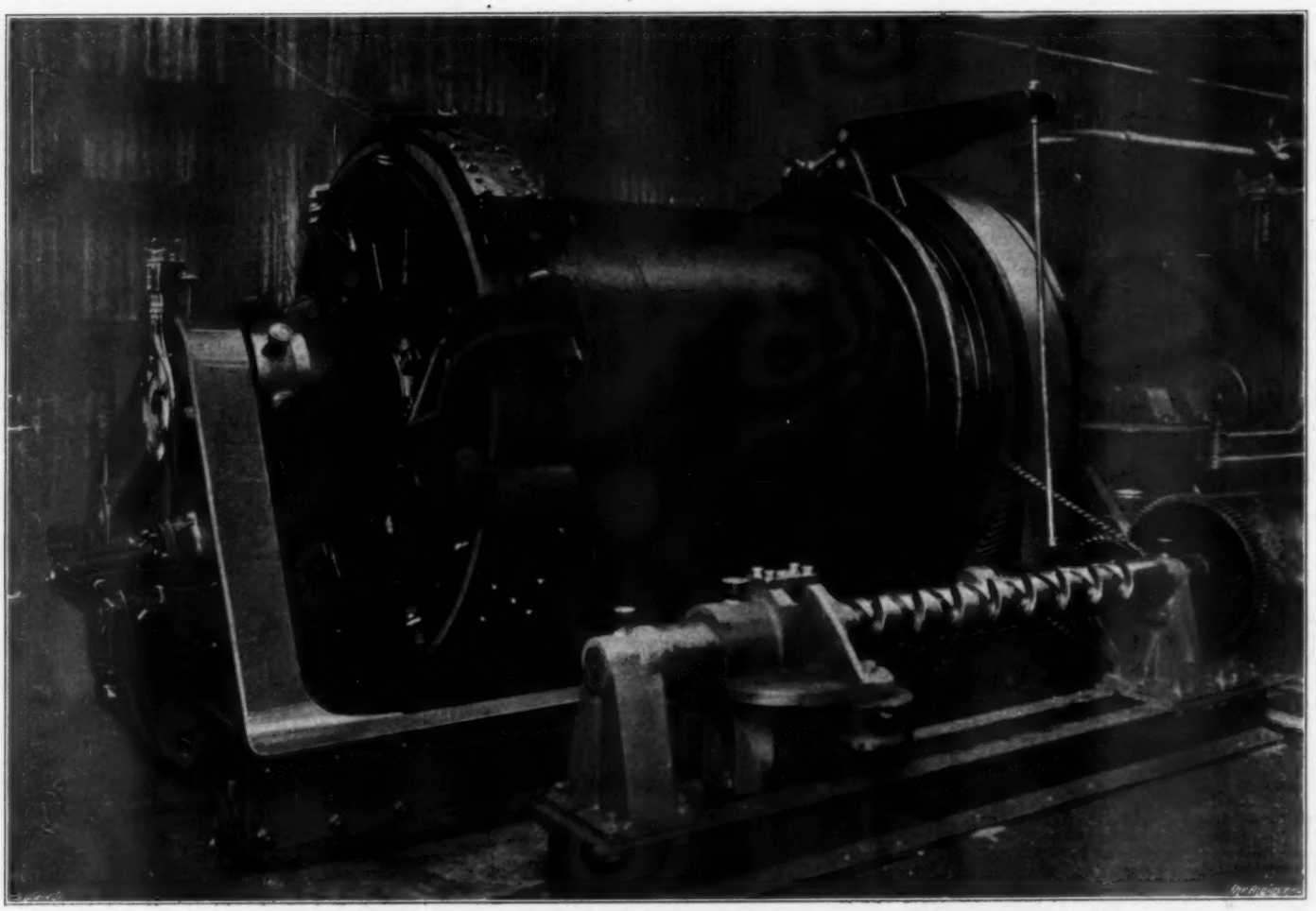

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THE ENGINEER.

MARCH 18, 1927.

The Navy Estimates.

IN spite of a marked increase in the Votes for new construction and the Fleet Air Arm, and the provision made for extra charges, amounting to nearly £1,000,000, arising from causes beyond the control of the Admiralty, the Navy Estimates for 1927 are £100,000 less than those for the current financial year, which stand at £58,100,000. But, as the First Lord acknowledges in his statement, even this small saving would not have been possible but for the circumstance that progress on new ships was retarded by the dearth of material owing to the coal stoppage. The gross reduction in expenditure as compared with this year totals £1,795,000, the largest economies having been made under Sections I. and II. (Personnl and Matéri l) of the Shipbuilding Vote, and in the Votes for Victualling and Clothing, Works, Naval Armaments, Educational Services, and Miscellaneous Effective Services. This saving, however, is overbalanced by the increased provision for contract shipbuilding and non-effective services. It is easy to lecture the Admiralty on the need for retrenchment, but as long as the Navy is maintained at the existing standard of strength which is rightly deemed to be the minimum consistent with reasonable security, there is, we fear, no hope of any substantial reduction in the yearly bill. After all, it is consoling to reflect that in 1927 we shall be spending on naval armaments £7,000,000 less than the United States, where, oddly enough, there is a great deal of talk about the "orgy of expenditure on war preparations" in which benighted Europe is supposed to be engaged. Before turning to the detailed Estimates, certain interesting points raised in the First Lord's statement may be briefly considered. Important changes in the distribution of the Fleet are contemplated for 1927. The Nelson and Rodney on passing into service are to join the Atlantic Fleet, which will further comprise the four "Iron Dukes" and three battle-cruisers. At the same time four or five ships of the "Queen Elizabeth" class and four or five of the "Royal Sovereign" class will be attached to the Mediterranean Fleet, which will thus have a contingent strength of ten 15in. gun battleships, as against its present quota of six of these vessels. On the China station the five cruisers at present serving there—two "Raleighs," two "D" and one "C" class—are to be relieved by the five cruisers of the "Kent" class, now completing. The future squadron, composed of these powerful 10,000-ton ships, with a uniform speed of 31½ knots and a main armament of eight 8in. guns, will worthily represent our interests in the Far East, while the older vessels which they relieve will provide a much-needed reinforcement for the depleted cruiser divisions of the Mediterranean and Atlantic Fleets.

The programme of new construction for 1927 embraces the following ships:—One "A" cruiser, two "B" cruisers, one flotilla leader, eight destroyers, six submarines, and two minesweepers. With the exception of the two "B" cruisers, which are to be built in H.M. Dockyards, the contracts for all the foregoing vessels will be placed with private firms. No news could be more welcome to our sorely tried shipbuilding industry. While there is, no doubt, a bare possibility that the execution of this programme may be affected by the outcome of the naval conference to be held at Geneva in the summer, we think it more than probable that all the ships enumerated will be built according to plan. It is interesting to observe the revival of the flotilla leader, a type which has been in abeyance since the war, though its utility has been amply demonstrated. The four motor launches—presumably C.M.B.'s—originally projected for 1927, have been cancelled, and in their place two vessels combining the functions of minesweepers and sloops are to be built. These units have been designed to fulfil economically the many important fleet duties for which small ships are required, particularly on foreign stations. Of the three cruisers, one will be of 10,000 tons and the others of 8000 tons. It is announced that the minelayer Adventure, which is equipped with a Diesel cruising installation, has satisfactorily completed her steam trials and will pass into service shortly. The destroyers Amazon and Ambuscade, of experimental design, were delayed in their steam trials by the occurrence of defects in the main turbines, but the trials have since been resumed. In this connection we note with satisfaction that both vessels have now passed the contract speed in their trials on the Clyde. A fairly large programme of reconstruction is in hand. The Queen Elizabeth is receiving bulges, the Centurion is being converted into a target ship to replace the Agamemnon, the Resolution is being re-tubed, and the conversion of the Courageous and Glorious into aircraft carriers is proceeding. The estimated total cost of rebuilding the Courageous is no less than £2,025,800, a truly formidable figure. Further heavy items for refits are £629,039 for the Queen Elizabeth, £358,088 for the Centurion, £276,591 for the Resolution, £104,936, £109,088, £109,197, and £118,365 respectively for the small cruisers Caradoc, Ceres, Cleopatra, and Constance, the two last-named ships being twelve years old; £46,242 and £50,208 for the sloops Cornflower and Verbena; and £104,847 for the repair ship Assistance, which was launched twenty-seven years ago. It is to be hoped that the expenditure of such large sums on ships no longer in their prime is justified. Turning to new construction, we note that the Nelson and Rodney are due for completion in the financial year 1927. In both cases the estimated cost has been exceeded, though not by a great margin. The Nelson, built by Sir W. G. Armstrong-Whitworth and Co., Ltd., represents a total outlay of £6,483,879, inclusive of guns; for the Rodney, built by Cammell Laird and Co., Ltd., the corresponding figure is £6,566,884. The tabulated details of these ships show them to have an unusually large fuel capacity, viz., 4000 tons. This exceeds the oil stowage of the Queen Elizabeth by 600 tons, and is equal to the maximum capacity of the Hood, a ship of greater displacement and more than thrice the horse-power of the "Nelson" class. It is evident that the Nelson, with bunkers full and other supplies on board, will displace nearly 40,000 tons, or 5000 tons more than the "standard" figure. The armament of this class is already known, as, indeed, are all essential particulars of the two ships. On the other hand, certain details of the new cruisers are now released for the first time. The five ships of the "Kent" class have been built to the same design, the characteristics of which are as follows:—Length, 590ft.; breadth, 68ft. 4in.; mean draught at the standard displacement of 10,000 tons, 16ft. 3in. The machinery develops 80,000 horse-power, with a corresponding speed of 31½ knots in smooth water and in light condition. The total oil fuel capacity is 3400 tons, exceeding that of our largest cruisers now in service—the "Raleighs"—by 1250 tons. Thanks to this great increase in fuel stowage, the new ships should have a very wide radius of action, which accords with their primary function of commerce protection. The main battery of eight 8in. guns is supplemented by four 4in. A.A. and four 3-pounder guns, with eight 2-pounder pom-poms. Details of the four "Londons" and the three "B" class 8000-ton cruisers now building or on order are not yet available. Our first post-war submarine, the

X 1, having concluded her trials and joined the First Flotilla, is not listed in the new Estimates, but the second boat, the Oberon, is still a charge on the naval budget. The estimated total expenditure on this vessel, excluding armament and ordnance stores, is £596,605, an amount that should give pause to those who argue that submarines constitute the most economical form of naval defence. Twenty-four additional submarines are projected for the ensuing three years, and six have been already ordered. The four gunboats for service in China have been delayed by the coal dispute, but the initial shipments of material to Hong Kong, where the vessels are to be assembled, have begun. They are ships of 262 to 310 tons, with speeds of 14 to 16 knots, armed with two 3in. guns. No details, financial or otherwise, of the submarine depot ship Medway or the repair ship Resource, both recently ordered from Vickers Ltd., are contained in the Estimates. The floating dock No. IX., under construction by Swan, Hunter and Wigham Richardson for the Singapore base, is expected to absorb £374,719 up to the end of the coming financial year. The total cost of this structure is unofficially estimated at £1,200,000.

Provision is made in 1927 for a naval personnel of 102,275, which is 400 less than the existing establishment. It would have been necessary to increase the total but for the delay in completing new ships. Apart from the expansion of the Fleet Air Arm, reflected in the larger votes both in the Navy and the Air Estimates, there is evidence of the special attention which naval aviation is now receiving. Ninety-five naval and marine officers have qualified as pilots, and twenty-eight more are under training. Furthermore, fifty-eight naval officers have been trained as observers. Besides these qualified ranks a number of junior executive officers have gone through short training courses in the aircraft carriers attached to the Fleet, and a Committee has now been appointed to consider the whole question of instructing junior officers of the Navy in air work. Of the officers already on air service the First Lord writes :—"A very high standard has been reached in the execution of their flying duties with the Fleet, and has assisted very materially in the progress made in the use of aircraft at sea." Distinct progress is recorded in general fleet training, gunnery, torpedo, anti-submarine, and anti-mine exercises. That the Navy is not unmindful of the air menace is made clear by the augmented high-angle batteries of new ships, and by the First Lord's confident assurance that "we shall shortly be in a position to say that the A.A. defence of the Fleet has become a formidable obstacle to every form of air attack on surface ships."

Reticence.

It is sometimes said, we know not with how much truth, that the engineers of other nations are more ready to exchange knowledge than those of this country. To the Americans, in particular, credit is given for the willingness with which they give particulars to their Technical Press and privately to other firms in the same line of business. As far as the Press is concerned, we cannot say that the American papers are richer in detailed drawings than British papers or that their technical institutions are really much in advance of ours—save in quantity—where scientific contributions are concerned. As to what may be imparted privately, it is not possible to speak with much certainty. But we have only to consider the readiness with which our own great engineering works throw their shops open to the visits of all sorts and kinds of institutions, to feel that the reserve, if any, is of a relatively mild order. On one or two occasions we have known certain visitors barred. But that has always been done, within our knowledge, at the instruction of some Government Ministry or Department, which had international reasons for preserving secrecy.

Yet with it all there is still too much reticence between engineers themselves. A recent case, which unfortunately we cannot specify, has brought the matter to our minds. In it two firms were given similar orders. The work involved was a little out of the common, and both firms encountered the same difficulty. Had they put their heads together their combined experience would have lightened the search for a solution. But neither would think of approaching the other, and each had to make costly experiments and purchase knowledge through failure. Such things should not be, on the one hand, because they cause delay, and, on the other, because they add greatly to the final cost. We have known instances, too, where, not infrequently in Admiralty orders placed with several firms, one firm has discovered a defect or weakness. It has perchance even had a breakdown owing to a not apparent fault in a design common to all. The right thing to do would very obviously be to circulate the information to the other firms. But the reverse policy is followed. The firm keeps as quiet about it as possible, and actually chuckles to itself when it hears subsequently that others have run upon the same snag. One would imagine that in such circumstances it would be the duty of the resident Admiralty overseer to indicate the approaching trouble. But that is contrary to etiquette. All the overseers are informed by the Admiralty, but they may not help one firm with the experiences of another. Again, what engineer is there who, having sat at a conference on some common technical difficulty, has not observed how all the others were as reticent as they could be, each hoping to receive, but avoiding giving. They came to collect, but not to subscribe. We recall a notable case at a very critical point in the nation's history. Had a strong independent man taken the chair at those conferences and said, "Gentlemen, you may desire amongst yourselves to hedge, you may desire to preserve your knowledge, or to conceal your ignorance, but you have got to tell *me*," then a solution would have been found more readily and far more cheaply. Who does not recall the very poor and reserved discussions which took place on the wear of double reduction gear for ship propulsion. All the cards were never laid upon the tables, and often enough those who knew excused themselves from taking part in a debate. We may well ask why should such things be? Why should firms reserve information when they might fairly count upon receiving in return other information of equal value? The answer is, we believe, two-fold. In the first place, there is inevitable rivalry, not an unhealthy thing in itself, but bad when carried into wrong issues. Then there is the fear that purchasers, potential or actual, may hear of the defects and draw injurious conclusions. Hence every effort is made to hush them up. A firm A which encounters trouble does not let a firm B know because it believes that B will whisper it to C, who will transmit it to the market. It is bad for the credit of engineers that such fears should be able to exist. They would serve the whole industry and themselves better did they agree to circulate, in confidence, amongst themselves, knowledge so acquired.

We have spoken of engineers, but it would be wrong to suppose that they are exceptional. The same bad practice is pursued in all industries. When the Department of Scientific and Industrial Research came into existence, one of its first difficulties was to persuade diverse firms in any one industry to form a Research Association. All feared that they would be compelled to reveal secrets that they had preserved for years. In several cases where such associations were formed, it was found that the secrets which had been so jealously guarded were common property! Thus no doubt it would be in engineering. But we have in mind not so much those cases in which general practice is concerned as those in which a new development has to be made to meet new conditions. It is in such instances that the benefit of the whole industry is of far more importance than the benefit of a single firm. We sympathise with the very natural desire of an engineer who has won his way through a difficulty by his own enterprise and at his own expense to secure such advantage as it gives. But in nine cases out of ten the work is being duplicated elsewhere, and the cost to the industry is at least twice what it might be. Moreover, it is now appreciated that it is profitable to every member of an industry if all the members are prosperous. One does not gain so much at the expense of others as in conjunction with them. An international reputation may be built up if many firms do excellent work, as may be seen in our agricultural engineering and railway plant industries, and results in large orders coming to the country. On the contrary, if but a single firm stands in the highest repute, the hold of the nation upon foreign markets is far less secure.

Obituary.

ALFRED JOHN HILL.

Universal regret will be felt at the sudden death of Mr. A. J. Hill, late Chief Mechanical Engineer of the one-time Great Eastern Railway, which took place on Monday last, the 14th inst.

Alfred John Hill, who was the son of the late Mr. Thomas Hill, of Peterborough, was born in that town in 1862. He was educated privately and was apprenticed in 1877 at the Locomotive, Carriage and Wagon Works of the Great Eastern Railway at Stratford, where he was destined to spend the whole of his professional life. On completing his apprenticeship he entered the drawing-office in 1882, where he remained for eight years. In the year 1882, too, he gained a Whitworth Scholarship. In 1890 he was made Works Manager's assistant, and a year later Assistant Works Manager. Seven years later—that is to say, in November, 1898—he became Acting Works Manager, and was promoted to full Works Managership the January of the following year. That position he held till October, 1912, when he became Acting Locomotive Superintendent. He was made Locomotive Superintendent in 1913 and Chief Mechanical Engineer in April, 1915, a position which he held till March, 1923, when he retired.

During his apprenticeship he was a student and, later, a teacher at the Railway Company's Mechanics' Institution at Stratford, and, subsequently, he acted as Chairman of Committee for twelve years. He took a very keen interest in railway ambulance work, and was instrumental in bringing about the adoption of systematic ambulance training for the staff of his line, thereafter acting for many years as Honorary Secretary for the Ambulance Corps throughout the Great Eastern system.

During the war Mr. Hill was Chairman of the southern group of railways for the manufacture of munitions, and he also represented all the railways of the country on the Priority Branch of the Ministry of Munitions. In 1917 he was sent to America by the Government in connection with the supply of materials which were urgently required for the railways. He was made G.B.E. for his war services.

Mr. Hill acted as Chairman of the Carriage and Wagon Superintendents' meetings at the Railway Clearing House for the three and a-half years ending March, 1923. He was a member of both the Institution of Civil Engineers and the Institution of Mechanical Engineers. To the former he contributed two papers, one on "The Use of Cast Steel in Locomotives" and the other on "Repairs and Renewals of Railway Rolling Stock." For the first he received a Miller Prize and for the second a Watt Medal, a Crampton Prize, and a Telford Premium. He was also a member of the Institution of Locomotive Engineers and was president of that body for the two years 1914–1915.

Institution of Chemical Engineers.

No. I.

At the beginning of this session, the Council of the Institution of Chemical Engineers decided to abandon its usual practice of holding one meeting a month in favour of a longer meeting every three months, or two during the session. The first of these was held in November and the second took place in London on March 9th, 10th, and 11th, when a two days' conference was held at Burlington House, followed by the annual general meeting and a technical paper, together with the annual dinner at the Hotel Victoria, on March 11th. It may be here stated that at the annual general meeting on March 11th Sir Alexander Gibb was elected president.

The proceedings opened at Burlington House on Wednesday afternoon, March 9th, when two papers relating to "Lead as a Constructional Material in Chemical Engineering," by Mr. S. J. Tungay, and "The Production of Dissolved Acetylene and its Application to Lead Burning," by Mr. W. C. Freeman, were read and discussed.

Lead as a Constructional Material.

Mr. Tungay pleaded for greater attention to be paid to lead from the metallurgical side, and said that in considering lead as a constructional material for chemical plant the mind of the chemical engineer immediately went out to its application in the construction of sulphuric acid plant and its wide use in handling sulphuric acid. Those were unquestionably the most extensive applications of the metal in chemical industry, but there was a very large number of other uses to which attention should be directed. Figures of analysis were given showing that the greater the purity of lead the more resistant is it to the attack of acid, and it was pointed out that lead having a purity of 99·99 per cent. is obtainable.

In addition to its use for sulphuric acid plant, however, acid-resisting lead has a very widespread application in the construction of concentration plant for the concentration of sulphuric acid and phosphoric acid, and for plant for sulphonation and chlorination processes. It is also used in large quantities for the construction of sulphate of ammonia plants, and no metal has been found on an industrial scale so satisfactory as lead as a medium for the construction of this plant. Many other uses of it were mentioned. A point emphasised in this connection was the coating or covering of other metals with lead, a matter which has received much attention both in Europe and the United States. Several continental firms maintain that they possess either secret processes and methods or have specially trained and skilled operatives enabling them to produce homogeneously lead-lined steel vessels or parts, the lining or coating of which, when finished, is in such a condition that

the lead and steel surfaces are perfectly united and separable only by chiselling or melting the lead. There have also been put forward from time to time numerous methods for coating with lead by painting or coating with lead particles suspended in solution. Mr. Tungay states, however, that whilst these paints or coatings of chemical lead may possess some advantage as a resistant to corrosion by fumes or occasional splashes of acid, it is obvious that their mechanical resistance cannot be great.

As opposed to the use of pure lead for chemical plant, it is often found desirable to employ a form of hard lead or regulus metal. Whilst not so thoroughly acid-resisting as pure lead, the greater mechanical strength of this alloy more than compensates for this drawback. This lead, of course, has a wide application for castings of various kinds in chemical plant, and the author points out that in order to ensure regulus metal satisfactorily resisting the action of sulphuric acid of various concentrations up to, say, 80 per cent., it is important that it should be made of new metals comprising lead of 99·9 per cent. purity and antimony of 99·5 per cent. purity Unless the metals used for producing the alloy are of the purity named it will be found difficult to obtain castings free from flaws or segregations.

Mr. W. C. Freeman, in his paper, related something of the history of the development of lead burning down to 1923, when the acetylene-air flame was introduced. The pressure of the acetylene as it issues from the cylinder is utilised to induce, on the Bunsen principle, a sufficient volume of atmospheric air to complete the combustion of the acetylene at the blow-pipe tip. There are limitations to this method, however, and the oxy-acetylene blow-pipe has followed. These oxy-acetylene lead burning plants are claimed to provide a stable flame of maximum temperature combined with minimum velocity and delivered from a blow-pipe having exceptionally small tip orifices. This combination makes the operating rate so rapid that there is practically no loss of heat by conductivity, whilst the consumption of both gases is so small that long burning periods are provided from small portable cylinders—where portability is essential—an example being that a total burning period of about eleven hours can be provided from a 12 cubic feet cylinder of dissolved acetylene and a 15 cubic feet cylinder of oxygen, the two weighing about 27½ lb. Owing to the purity of the combined gases it is stated that no electrolytic or galvanic action in the lead need be feared. Thus this process of lead burning, said Mr. Freeman, has triumphed over the popular anticipation that the phenomenally high temperature of the oxy-acetylene flame would be a deterrent. A range of blow-pipes capable of dealing with lead burning work of varying magnitude were exhibited and demonstrated.

In the discussion, Mr. P. Parrish recalled how, at the Congress of Chemists in London last summer, he made an attack on the proposals of the B.E.S.A. in regard to the draft specification for chemical sheet lead, and, he added, he had nothing to retract from the criticisms he then made. His complaint was that the draft specification makes the quality of chemical sheet lead dependent on the content of copper, and he considered that to be very unwise and inexpedient. He attached little or no importance to the flash test, because that could be made anything according to the circumstances. Whilst a flash test might be a very good test in determining the purity and suitability of chemical sheet lead for certain purposes, other tests must not be ignored. As regarded attaching lead to other metals, whilst spraying might be suitable in certain cases, the real need was for a consolidated sheet which had been rolled at a definite temperature and pressure and which could be attached in such a way that there was no fear of dislodgment afterwards.

Mr. F. H. Rogers referred to a case of lead which corroded badly and was found to contain ·003 per cent. of antimony. A precisely similar lead without the antimony behaved perfectly properly.

Mr. G. B. Jones urged the need for considering and investigating chemical lead more from the metallurgical and engineering point of view than had been the case hitherto.

Mr. Tungay, dealing with the question of the draft standard specification for chemical sheet lead—he is a member of the sub-committee—said the proposal was merely that a user could include copper if he wished to. It did not make it compulsory, and the reason was that the sub-committee had tested a large number of samples of lead which had stood up quite well in sulphuric acid plants and yet had in them a trace of copper. Hence it was not felt that copper could be regarded as an impurity. The real point was that the sub-committee was extremely anxious to get the views of those constantly in touch with chemical lead under practical conditions. It would be extremely valuable, of course, if some methods of testing lead could be evolved which would give the results obtained under practical conditions, but it was not always convenient for chemical manufacturers to adopt such tests. With regard to a method of homogeneously combining lead with other metals, he said he could not believe that all the brains in connection with that work were on the Continent or in America, and he looked forward to a process being evolved here.

The second session, on Wednesday evening, was devoted to the discussion of methods for the intensive manufacture of sulphuric acid. Sir Frederick L. Nathan, the President of the Institution, was in the chair, and two papers were presented.

INTENSIVE SULPHURIC ACID MANUFACTURE.

The first of these papers, which was presented by Dr. H. J. Bush and Mr. Arthur Grounds, discussed the function of the Schmiedel box in the manufacture of sulphuric acid. It was pointed out by the authors that the immunity which the metallurgical industry has enjoyed, and is now enjoying, from prosecution for the emission of fumes of sulphur dioxide is likely to come to an end. Legislation is expected which will compel metallurgical works to render their exit gases harmless, and in the near future they may have to reduce their exit gases to the figure allowed by the Alkali Acts.

The first experiments with the Schmiedel box were undertaken some eight or nine years ago with a crudely constructed box at a chemical works at Nürnberg, where there was an ordinary chamber plant burning, partly, pyrites from coal brasses and, partly, spent oxide. One of the chambers, which was due for renewal, was taken down, and a rectangular leaden box, fitted first with one revolving roller, and later with two, was put into its place. Later more boxes were added to the plant and another chamber eliminated. The first commercial Schmiedel plant to be erected was at Ausserfelden, in Austria, and it has now been running continuously for about five years. It consists essentially of two drying towers, six Schmiedel boxes and five absorbing vessels, together with the necessary fans, acid circulating pumps and catch tanks. Of the six boxes, the first acts as a denitrating box, the next four as production boxes, whilst the last, or water box, performs a special function. This plant, however, is inferior to the modern Schmiedel plant.

Schmiedel boxes have now been incorporated in six of the sulphuric acid works in England and Wales. The number of boxes actually installed is thirty-three, and they have been built partly as complete Schmeidel units or partly as units incorporated with a view either to replacing chambers or towers or simply to add to acid production. For the latter purpose the Schmiedel box is admirably suited, since, when demands for acid become heavy, one or more boxes can easily be switched into the circuit, whilst if the acid demand falls the necessary number of boxes can be switched out. Two "pure" Schmiedel plants have been installed, both at metallurgical works where zinc blende is roasted for the production of spelter, the sulphur dioxide coming from the roasters being used for the manufacture of sulphuric acid. In neither case, however, have the boxes come up to expectations, and manufacturing experience, assisted by careful chemical tests, has shown the view of the originators that a series of boxes could entirely replace chambers to be erroneous. On the other hand, experience with a combined plant operating in North Germany has shown that the optimum conditions are secured when Schmiedel boxes are combined with reaction towers. Figures resulting from the working of this plant show that the true function of the Schmiedel box is not so much that of a producing unit *per se*, but of a preparation unit in which the gases are converted into such a physical and chemical state that they will react very vigorously in the reaction chamber. This has been demonstrated quite recently in a plant in the North of England. In this plant, which was formerly a normal chamber plant, the highest concentration that could be obtained in the first chamber when operating normally, i.e., following directly on the Glover tower, was about 118 deg. to 120 deg. Tw. When, however, the gases passed from the Glover tower through three Schmiedel boxes, arranged in parallel, and thence to the first chamber, in spite of the fact that this chamber was then getting gases weaker in sulphur dioxide, the concentration ran up to 136 deg. Tw.—in fact, to such a strength that oxides of nitrogen were being re-absorbed and dilution with water or weak acid had to be resorted to.

A new vista for the use of Schmiedel boxes has lately been opened up in the metallurgical industry in the desulphurising of base metal sulphides. Hitherto done largely in roasters with mechanical stirrers, the practice of so-called blast-roasting sulphides on Dwight-Lloyd machines is rapidly gaining ground, particularly as means have been found by a judicious adjustment of the air supply to obtain the sulphur dioxide in the waste gases in a concentration suitable for conversion into sulphuric acid. The gases being cold and wet, the plant to deal with them is limited to the catalytic contact plant and Schmiedel boxes. By a suitable arrangement of Schmiedel boxes and packed towers it is possible to utilise such gases of metallurgical origin, formerly sent to waste, and to produce therefrom at an economical figure sulphuric acid of from 75 to 78 per cent. Such an installation is in course of erection.

In the course of the discussion criticisms were made of costs of production of sulphuric acid by the Schmiedel process on the Continent; but, as Dr. Bush pointed out, the proof of the pudding is in the eating, and the sulphuric acid is being produced on a commercial basis.

The second paper, by Mr. W. G. Mills, discussed recent developments in the Mills-Packard chamber plant, of which there are now in existence sixty-four installations in various parts of the world. For the most part the paper deals with details of the plant, of which there are many drawings and photographs, but reference is also made to an installation of entirely new design erected last year at the works of Chance and Hunt, Ltd., at Birmingham. The chambers on this plant are strikingly different from the well-known standard type, the large diameter, the more cylindrical shape, and the absence of the usual water gutters being particular features. The plant, which is to produce 350 tons weekly of 140 deg. Tw. acid, has two Glover and two Gay-Lussac towers and four chambers, and the gases dealt with come from spent oxide burned in De Spirlet furnaces. The chambers have the following dimensions:—Height, 48ft.; diameter of base, 35ft.; diameter of ceiling, 28ft. The volume of each chamber is approximately 36,750 cubic feet, giving a total chamber space of 147,000 cubic feet for the four chambers. The plant is designed to work at from 4·5 to 4·75 cubic feet per pound sulphur charged per twenty-four hours. The slope of the chamber wall is 13·714 : 1, as compared with 8 : 1 in the case of the standard chamber wall. A special system of hanging the lead on the chambers has been adopted.

During the discussion on the papers the opinion was expressed by Mr. P. Parrish that the intensive production of sulphuric acid would be carried out in the future by the atomisation of sulphuric acid in conjunction with the tower chamber. He did not say that in disparagement of the Mills-Packard plant, however, because it had served a very useful function and would continue to do so.

SIXTY YEARS AGO.

THERE is a curiously modern ring about a leading article which appeared in our issue of March 15th, 1867. We and the country in general were troubled at the moment with the threat of a general strike among the engine drivers and firemen. Strikes and lock-outs there had been in abundance previously, but the occasion of the moment was the first in which an industrial dispute had threatened to hold up the whole life and activity of the country. It was generally recognised that a strike of the drivers and firemen on our railways would, if carried to its fullest possible development, mean the total arrest of nearly all the operations of trade and commerce. The country would fall into a state of syncope and London, and many other large towns would be reduced to starvation as surely as if they were surrounded by a beleaguering army. Not only the employers and the employed would be affected. For the first time in the history of industrial disputes, the public as a whole would suffer. Many years previously in the infancy of the Eastern Counties line the men struck work in a body. Mr. John Braithwaite, the locomotive superintendent at the time immediately turned out, and with the assistance of "gentlemen-apprentices" and a few fitters, worked his traffic as if nothing had happened. Very soon the men returned to their work, completely beaten. We realised that the conditions of 1867 and the general character of the action threatened by the United Society of Engine Drivers and Firemen prevented Mr. Braithwaite's example being followed with success. The men demanded that a day's work should be reckoned at ten hours, or a run of 150 miles, and that various increases of pay should be made, so as to bring the wages paid per day up to 7s. 6d. in the case of drivers in London—the highest category—and 3s. 6d. in the case of firemen in the country—the lowest category. We expressed ourselves in favour of a revision of hours, for, on the grounds of public safety, we held that the shifts ordinarily worked were excessive. We expressed opposition to the wage advances claimed, not so much on the score of their magnitude, but because of the unreasonable and unfair manner in which the different categories were graded. Examining succeeding issues, we find that the threat proceeded to action in the case of at least one railway, the London and Brighton. For one day that railway was without trains, except those which Mr. Craven, the locomotive superintendent, was enabled to run with the assistance of thirty or forty extemporised drivers and firemen. Then many of the regular drivers living at Brighton returned to work, and the London men perforce had to follow. On other lines, we gather, the directors granted a proportion of the claims or the men deferred their action. No general strike took place. With our own experience of railway strikes and a still more general strike, we may perhaps be inclined to smile at the fears of our fathers sixty years ago. Let us, however, remember, and be thankful for the fact, that the progress made in alternative forms of transport since 1867 has placed us in a vastly improved position to overcome the effects of a hold-up on the railways.

IT is reported from Sofia that four well-known European firms—two German, one French, and one British—have tendered for the construction and equipment of a wireless telegraphic and telephonic station for that city. The estimate of the cost of the station was about 30,000,000 leva, but that sum was exceeded by most of the tenders sent in. The German firm of Lorenz (Berlin) made two offers, one for a station costing 95,000,000 leva and the other for a station costing 42,000,000 leva. The Telefunken firm (Berlin) also submitted two tenders, one at 54,000,000 leva and the other at 50,000,000 leva. The Marconi Company of London submitted two tenders, one at 60,000,000 leva and the other at 40,500,000 leva, while the French concern of Telephones Sans Fil submitted three, the first at 30,950,000 leva, the second at 32,200,000 leva, and the third at 29,000,000 leva. These offers are being considered, and a decision is expected shortly.

SUSPENSION BRIDGE OVER THE RIVER DELAWARE

(*For description see opposite page*)

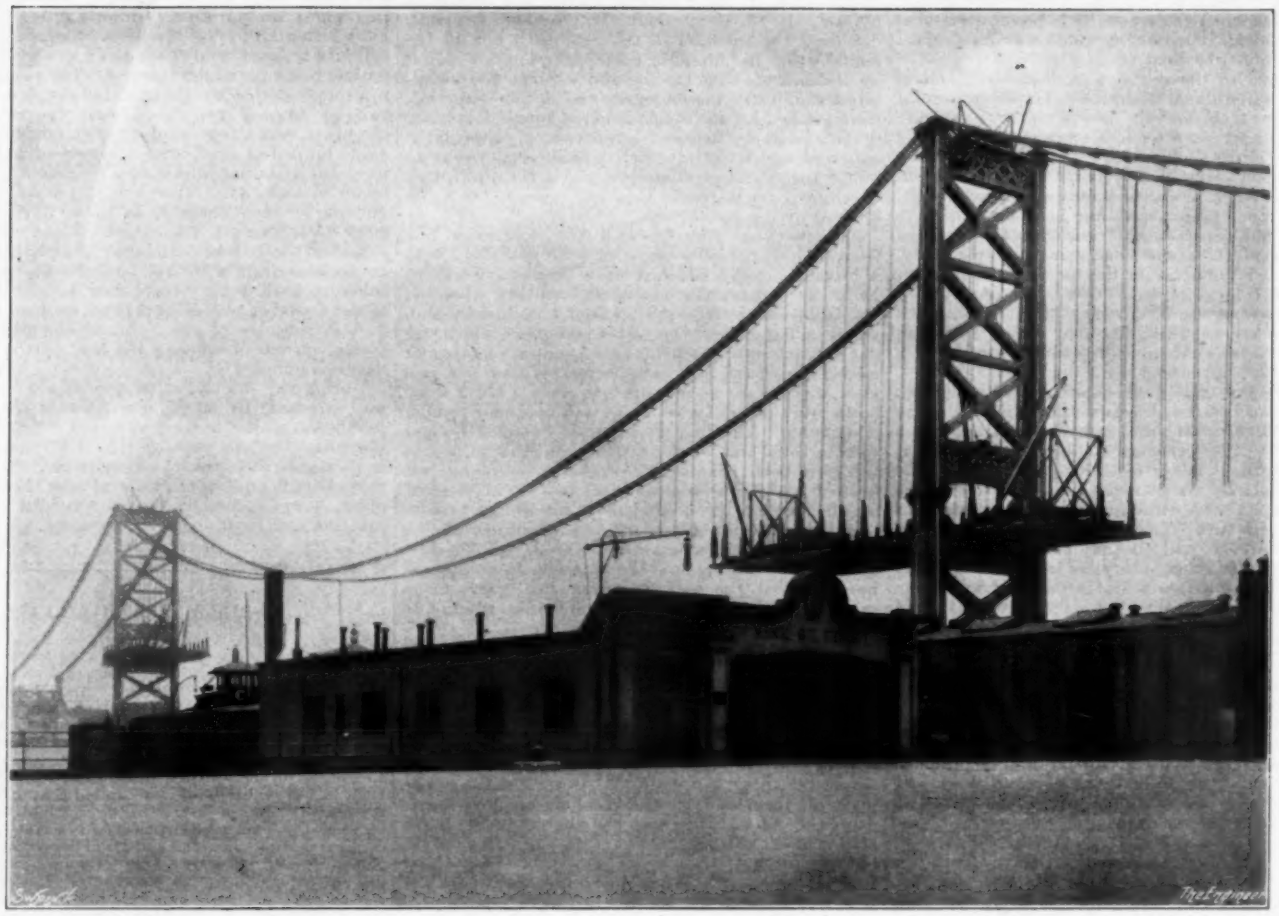


FIG. 11—STARTING THE SUSPENDED STRUCTURE—APRIL, 1925

FIG. 12—COMPLETING THE SUSPENDED STRUCTURE—MAY, 1925

Delaware River Suspension Bridge, U.S.A.

No. III.*

Stiffening Trusses.—The stiffening trusses which are suspended from the cables and carry the floor of the bridge, are arranged entirely below the cables, and their general design and arrangement are shown in Fig. 13. They are of only moderate depth—28ft. between centres of chords or booms—in order to avoid excessive rigidity in the structure. Transverse girders between the top booms of these trusses were planned originally for lateral stiffness, and would have been utilised to carry the framing for the elevated footways. Their effect in appearance, however, was considered undesirable, and this feature of the design was abandoned as being unsightly.

In the modified and adopted design, which aimed at the desirable combination of an open roadway and a laterally stable structure, the trusses and floor beams were designed to form a rigid three-sided frame, so that all lateral forces on the trusses would be distributed through the deck framing. This design also permitted the convenient arrangement of placing the footways at the level of the tops of the stiffening trusses, supported by cantilever brackets on the truss posts. From the cross-section, Fig. 14, it will be seen that the posts are strongly reinforced laterally by side ribs composed of web plates and flange angles.

In these trusses the panel or bay length is 20ft. 6in. in the main span and 20ft. 8in. in the spans, conforming to the spacing of the suspenders. The trusses are continuous in the main span, between the towers, and continuous from the towers to the anchorages. At the towers each truss is suspended from a bracket on the tower column by means of a hanger fitted to a pin in the bracket and a pin in boom of the truss. One of these hanger connections is shown in Fig. 15. At the anchorages, the end of each truss is supported by a rocking post which is seated on the shoe of the inclined steel anchorage frame already described. The rocker support is shown in Fig. 7 *ante*. In these trusses the top boom is of double-channel section, with built-up channels back to back and connected by double lacing over the top and bottom flanges. The bottom boom is of inverted trough section, built up of plates and angles and having double lacing across the bottom flanges. The posts are web plates stiffened by transverse diaphragms forming, with their angle connections, vertical ribs and flanges. Diagonal members are of box section, with four interior angles, top and bottom web plates and lacing or lattice bars on the two open sides. These typical sections are shown in Fig. 16.

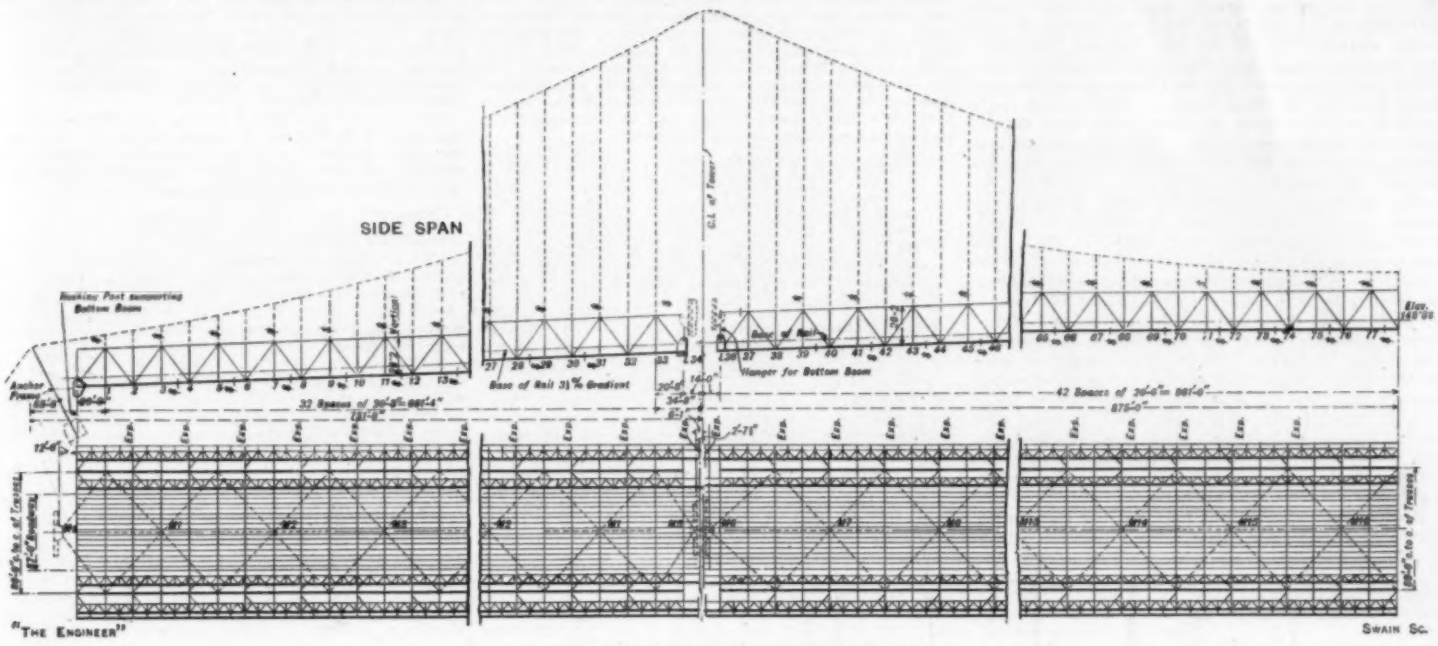


FIG. 13—ARRANGEMENT OF STIFFENING TRUSS

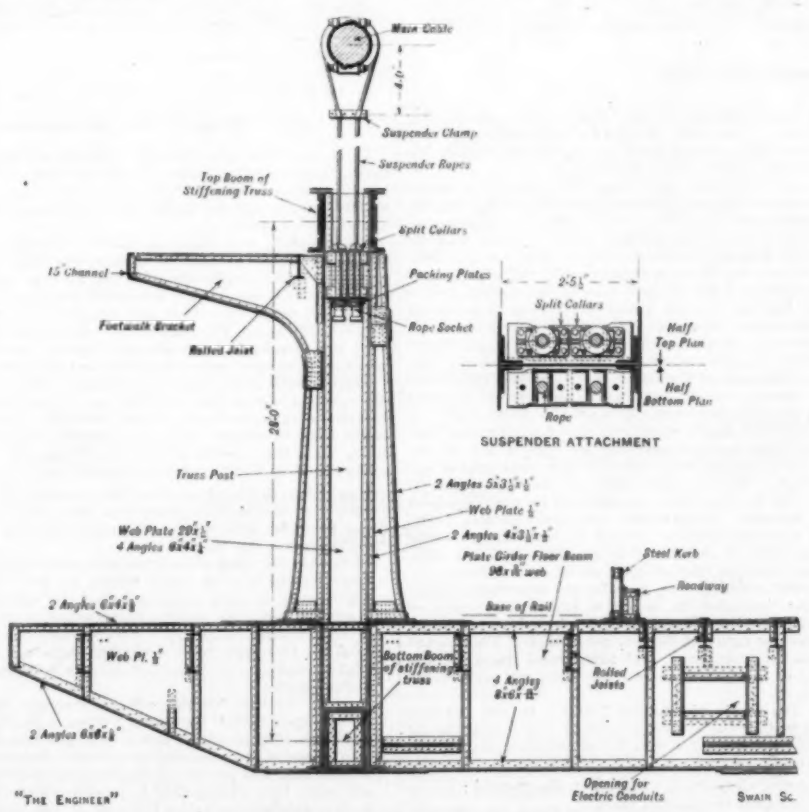


FIG. 14—RIGID TRANSVERSE FRAMING OF SUSPENDED STRUCTURE

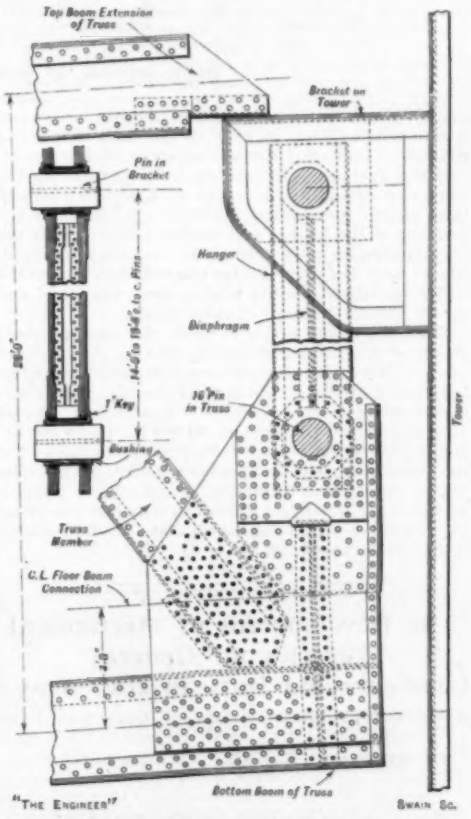


FIG. 15—SUPPORT OF STIFFENING TRUSS AT TOWER

Erection of the stiffening trusses was begun in March, 1925; those of the main span were finished in May, and those of the side spans in October. Work commenced at the towers, on which were mounted derricks with 106ft. jibs, by means of which the material was erected for the first four bays, or sufficient to carry the travellers for erecting the remainder of the suspended structure. In Fig. 11—April, 1925—the derricks are shown mounted on the towers and also the travellers in place on the deck to extend the work. In Fig. 12—May, 1925—the suspended structure is approaching completion.

Four travellers were installed, each having two jibs, 70ft. long, with electric winches. They were mounted on wheels riding on 85 lb. flange rails, forming a wide-gauge track carried by the steel floor system. On the first outward trip, starting from the towers, these travellers placed the bottom booms and posts or vertical members of the two trusses, with floor beams and lateral bracing. Returning, they placed the diagonal members of the trusses. On the next outward trip the top booms were placed. On the final return trip the floor system was completed, and the steel work of the footwalks and the railway and tramway lines was placed.

In closing or connecting the meeting ends of the north truss in the main span, the steel work—which had been erected with all splices bolted to permit of adjustment of the trusses to their dead-load position

* No. II. appeared March 4th.

before riveting—was hung from the cable and the length of the last panel opening for the top boom was within 4in. of the required length. By jacking apart the members of the boom on each side of this opening, the closing section of the boom was entered into place without difficulty. In the south truss the opening was of exact length, so that the last section of the boom was placed without any jacking.

Floor System.—As noted above, the floor beams and truss posts are designed to form a rigid three-sided frame—Fig. 14. Transverse plate girder floor beams, 8ft. deep, are riveted between the posts, while outside of the posts are cantilever brackets, making a total width of 125ft. 6in. for the floor framing. To carry the roadway, longitudinal bearers or stringers of 18in. rolled joists, spaced at 3ft. 10in. between centres, are fitted between the floor beams. They rest on angle brackets on the webs of the beams and have expansion joints at alternate beams. For the tramway and railway lines there are two plate girder longitudinals to carry each track.

The roadway is designed to carry 30-ton motor trucks with 7½-ton wheel loads, so that a heavily reinforced concrete slab, 6in. thick, is used with transverse steel trusses, 4½in. deep, embedded in the concrete. This slab is covered with a sheet asphalt pavement, 2½in. thick. On the viaduct approaches the slab is 7in. thick and carries a pavement of 3in. granite blocks. A 3in. concrete slab is used for the footways. Expansion joints in the concrete slabs on the suspension spans are provided at alternate panel points, the edges of the concrete being faced by bulb angles anchored into the slab. Toothed steel sliding plates provide for about 12in. of expansion and contraction movement at the hanger supports of the stiffening trusses, at the towers and at the rocking post supports at the anchorages.

Bridge Steel.—Structural material for the towers, stiffening trusses and floor system includes silicon steel, nickel steel and ordinary medium or carbon steel. Silicon steel, in view of the high unit stress allowable, was used for the columns of the towers and the anchorage frames, in order to provide the necessary strength with relatively light sections, and thus ensure the desired flexibility to allow for the bending of the towers and anchor frames under the varying stresses in the cables. For economy of weight, silicon steel was used also for the web members of the stiffening trusses, while nickel steel was employed for the booms or chords of these trusses.

With the ruling prices of steel, this use of special grades of steel was economical, leaving the ordinary grade of structural steel for members, which would be too thin if made of the special steels. Silicon and nickel steels were employed. The former has an ultimate tensile strength of 80,000 lb. to 90,000 lb., and a yield point of 45,000 lb. per square inch. For the nickel steel, with 3·2 per cent. nickel, the ultimate tensile strength is 95,000 lb. and the yield point is 55,000 lb. Throughout the entire structure the rivets are of mild steel, having an ultimate tensile strength of 52,000 lb. to 62,000 lb.

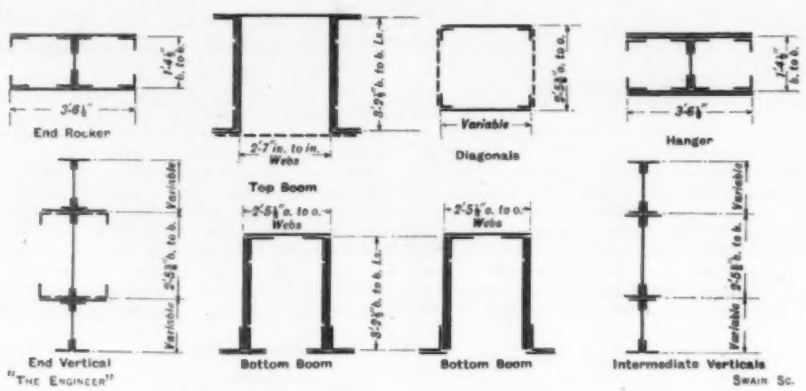


FIG. 16—SECTIONS OF MEMBERS OF STIFFENING TRUSS

The Development of Mechanical Vehicles for General Load-carrying Duty in the Army.*

WITH SPECIAL REFERENCE TO THE W.D. TYPE RIGID-FRAME SIX-WHEELED LORRY.

By CAPTAIN C. H. KUHNE, D.S.O., O.B.E., R.A.S.C., Associate Member.

Historical.—For the full appreciation of the present lines of development by the Army of general service load-carrying vehicles, it seems desirable to give first a very brief outline of their past evolution, and an indication of the circumstances which are guiding present efforts.

During the Great War mechanical transport came into its own. At the end of the war there were some 80,000 motor transport vehicles in use by the British Expeditionary Force in the main theatre of war in France and Belgium alone. The principal load-carrying vehicle was the 3 to 4-ton lorry on solid rubber tires. This type of lorry had been encouraged under the pre-war subsidy scheme of the War Department. It was an economical and reliable performer when road conditions were good, but, mainly on account of its great axle weight—some 5¼ tons on the back axle—and its low torque weight ratio, was a very poor machine for negotiating rough and soft ground and its ability to move off the road was negligible. On the other hand, it was found that, where conditions of war necessitated some degree of cross-country ability, vehicles of lighter axle weight, higher torque-weight ratio, and shod with pneumatic tires, such as the light Fiat lorry and the Ford van, could be used with a fair measure of success.

After the war it was desired to mechanise the Supply, Baggage and Ammunition Transport of the Division, which had hitherto been horse transport, viz., the old Divisional Train and Divisional Ammunition Column. Before doing this it was necessary to ensure the existence of a vehicle with a greater power of movement on bad surfaces than the old type of 3-ton lorry. A specification was therefore drawn up by the War Department for what became known as the War Department subsidy type 30-cwt. lorry. The leading features of the specification were :—

(1) Weight as low as possible ;
(2) High torque-weight ratio ;
(3) High speed ;
(4) Special cooling ;
(5) Large-size pneumatic tires ;
(6) Standardisation of various features in design, control, and equipment, and the use of B.E.S.A. standards as far as possible ;
(7) Suitability for commercial use.

Only by reduction of the useful load to 30 cwt., by the use of high-grade materials, by most careful design eliminating all unessential material, and by employment of pneumatic tires, could a design of vehicle be achieved which would give a fair cross-country performance. After some measure of hesitation certain manufacturers produced vehicles to the specification and the subsidy scheme was launched.

The scheme, initiated in 1923, may be said to have been a success in that the subsidy roll now contains its full quota of 1000 approved vehicles in commercial use, and ready for immediate use by the Expeditionary Force in emergency. In addition, a large number of these vehicles has been taken into use in the Peace Transport Service of the Army. They are in steady manufacturing production, and have created quite a considerable market for themselves for export within the Empire.

It is an unfortunate fact that the conditions under which commercial motor transport operates in this country tend towards the evolution of a somewhat degenerate type of vehicle from the military point of view, and for export to the Dominions and Colonies. But it is generally recognised that this W.D. specification of 1922, backed up by the subsidy and the co-operation of the manufacturers and users, has had a most beneficial effect on subsequent commercial vehicle design in general in this country.

Subsequent developments in aircraft, high-speed tanks, gun tractors, &c., have made it increasingly necessary that the general Mechanical Transport Service of the Army shall have still greater mobility as regards the time-load factor and the power to move anywhere off the made road. It is considered by many leading military authorities that superiority in respect of power of movement will be the deciding factor in the early stages of any considerable war in the future. Yet it is impossible for the Army to hold in peace time the very great numbers of general transport vehicles required immediately on mobilisation. Dependence must therefore be placed on the ability to take a large number of suitable vehicles straight from commercial employment into military use at short notice.

The 30-cwt. subsidy lorry was in one important aspect retrograde ; in order to secure a reasonable power of movement it had been found necessary to reduce the useful load to the low figure of 30 cwt. per vehicle. This meant more vehicles, more men, and more road space for the movement of a given tonnage. All these are undesirable features in war.

Salient Desiderata of Military Lorry.—It was natural, at this stage, that the attention of those responsible should be focussed on the development of vehicles having the following main features :—

(1) Lower intensity of pressure on the ground ;
(2) Increased useful load capacity ;
(3) High speed ;
(4) Higher torque-weight ratio ;
(5) Greater powers of adhesion to make use of the tractive effort available ;
(6) Increased flexibility in construction, giving ability to traverse rough ground without setting up undue stresses in chassis ;
(7) Reasonable first cost ;
(8) Economy in running and maintenance ;
(9) Attractiveness to the commercial user at home, as well as in the Dominions and Colonies ;
(10) Ease of handling.

The track or semi-track machine appeared at first sight to be the only type which would meet many of these requirements, and it is certain that such vehicles have a greater ability to negotiate certain extreme conditions of terrain than any other. But if items (3), (7), (8), and (9) be examined, it is apparent that there is no immediate prospect of the track machine complying with these essential requirements. Hence it would appear that the track vehicle should be called for as sparingly as possible in war establishments, and its use be confined to essential cross-country work in the very forefront of the Army Transport organisation, where unrestricted movement, irrespective of obstacles of terrain, is most essential.

It seems certain that the full quota of the Army's essential track or semi-track machines must, in present circumstances, be held in stock in peace. Such track machines were fully described in the admirable and comprehensive paper presented by Mr. L. A. Legros, O.B.E., before the Institution,* as well as in various other authoritative articles and papers.

By a natural and logical process those responsible for the general Mechanical Transport Service of the Army have been impelled to examine methods of improving the wheeled vehicle, with a view to incorporating in this type the desiderata which have been enumerated.

THE W.D. RIGID-FRAME SIX-WHEELED VEHICLE.

It will be obvious that the solution of the problem lay in the provision of a greater area of contact with the ground per unit of load carried. This increased area of contact was required, first, to prevent sinkage on soft ground, and second, in order to be able to apply the tractive effort over a greater ground area, and thus secure improved adhesion.

Vehicles of normal lay-out towing trailers, met the first condition, but not the second. An example of this is the well-known type of flexible six-wheeled lorry, so familiar on the road. Here by using three axles, reduction of axle weight is achieved, but only the middle axle drives, and the adhesion available for tractive effort is poor.

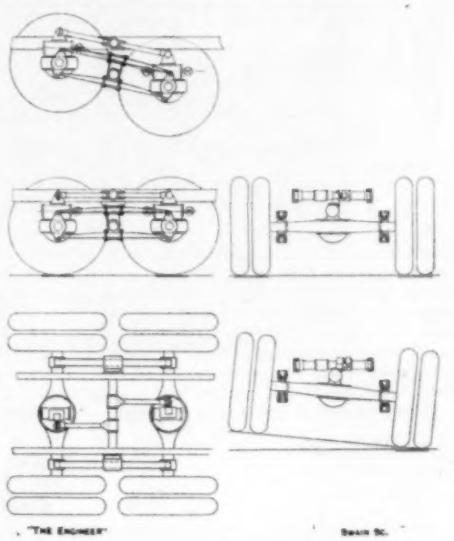


FIG. 1—Principle of W.D. Rear Suspension

Thus attention was directed towards a means of providing more driving wheels, and it was decided that what is now known as the rigid-frame six-wheeler, designed to drive on at least two axles, presented the most suitable line of investigation.

Examination was made of various foreign designs of multi-axle vehicles, and at about this time news was received of the performance of the French Renault six-wheeler, which made such wonderful journeys in tropical Africa. A sample machine was acquired for test by the R.A.S.C. Training Establishment, and trials carried out with this machine demonstrated beyond question that investigations were proceeding on the right lines.

After further most careful experiment and investigation the conclusion was reached that, apart from the general desiderata such as light weight, strength, high ratio of useful load to chassis weight, incorporation of standard units, &c., the salient points on which the successful performance of the six-wheeler depends are :—

(*a*) That the suspension of the driving axles must be such that the exertion of tractive effort shall not disturb the distribution of weight of the four driving wheels on the ground in any way.

(*b*) That the suspension must also permit of free articulation of the driving axles, within as wide limits as is practicable, in such a manner that the springs are not distorted, nor the weight distribution over the four driving wheels disturbed. This enables the wheels to conform to rough ground without affecting the drive, whilst causing a minimum of chassis displacement and distortion.

(*c*) That a high tractive effort is required, and should be obtained rather by gearing down a moderate-sized engine than by provision of a very large engine.

(*d*) That a low intensity of pressure between driving wheels and the ground is required to reduce sinkage, and some form of non-skid to enable sufficient adhesion to be obtained to make full use of the high tractive effort provided, when travelling over soft or friable ground.

It was found that none of the existing designs (all foreign) complied entirely with (*a*), (*b*), and (*d*).

It is proposed to indicate how these special features have been provided for in the W.D. design:

Suspension.—The vehicle has three axles. The front axle is quite normal, having Ackermann type steering and wheels which do not drive. This axle is connected to the chassis by normal semi-elliptic springs. Under the load are two driving axles close together.

* The Institution of Mechanical Engineers.

* "Proc." I. Mech. E., 1918, page 55.

There is no doubt that the vehicle would be more suitable for military purposes if the front wheels were driving also. This would enable it to negotiate steep-sided ditches and vertical banks. But the complications and extra cost necessary to attain this object would have ruined completely any chance of commercial adoption in this country.

There are several reasons for the disposition of the axles as described. If the three axles be equally spaced over the length of the vehicle the effective "belly clearance" of the machine is improved, but it becomes necessary to steer with both the front and third axles and complications of drive, &c., arise. Furthermore, it becomes impossible to keep all six wheels in contact with the ground when traversing rough country unless the frame of the machine is itself articulated. Thus only by placing the two driving axles close together under the load could a simple form of transmission be employed, and the correct load distribution over these axles be maintained when crossing rough ground.

W.D. Principle of Rear Suspension.—Fig. 1 shows in diagrammatic form the suspension principle of the two driving axles which is now considered the best, and which has been designed and is being patented by the W.D. The special features secured will now be described.

(*a*) To ensure that the wheels can conform freely to rough ground, irrespective of spring action, the bogie system shown was adopted. The axles are free to rise and fall relatively to one another within certain limits.

(*b*) To ensure that the weight distribution over the four driving wheels should not be disturbed by virtue of the application of the driving torque it was necessary that the torque reaction should be taken from each axle to the main frame of the vehicle, and not from axle to axle. This may be done by means of the two horizontal links shown, and no vertical load components are produced by the torque. This assembly permits an action in which, for all relative positions of the two axles, the worm shafts remain parallel, and thus such displacement as occurs leaves the instantaneous angular velocity of the worm shafts and wheels unaffected. This has a very marked effect on keeping the stresses to which the transmission members are subjected within reasonable limits, and helps to secure the maximum possible adhesion between the driving tires and the ground. Fig. 2 shows the resulting effect when the torque reactions are not so balanced. The photographs show such a vehicle anchored at the rear and at the front, with forward and reverse drive applied respectively. It will be seen that the wheels of the driving axle that is leading in each case tend to lift, whilst the wheels of the driving axle that is following tend to dig into the ground.

(*c*) It was necessary also to ensure that the two driving axles could move out of the horizontal with complete freedom. Such movement must therefore not entail any twisting of the road spring leaves, and to ensure this the members carrying the ends of the springs are mounted, by a form of spherical joint or other similar device, on the axles. Fig. 3 shows the free movement attained.

(*d*) The road springs, which are in duplex inverted semi-elliptic form, are called upon, in addition to their normal functions, to transmit the tractive effort from axles to frame, and also to locate the axles. They require to be designed with considerable lateral strength to resist bending, and the main leaves must be held firmly by strong palms or other means at the centre of the springs to avoid spreading or lateral displacement. In addition to other advantages the duplex springs provide four master leaves to locate the axles relatively to the frame.

Transmission.—A very high tractive effort at low vehicle speeds and a high speed on the hard road were both called for.

There is a tendency in some foreign countries to incorporate what, to our eyes, appear to be very large, heavy and powerful engines. This necessitates a general increase in weight throughout the chassis which is most undesirable. Furthermore, it is certain that a vehicle which is over-engined for our home road conditions would appeal very little to the civilian user on whose adoption of the W.D. specification the success of the whole scheme of development depends. It was decided, therefore, to secure these antipathetic features of high road speed and very high tractive effort by the use of quite normal, or even somewhat small engines, relatively to the gross moving weight, in conjunction with a particularly wide range of gears.

The scheme adopted was to use a standard engine clutch and four-speed and reverse gear-box unit of normal size and range, and to introduce, behind it, a subsidiary reducing gear (usually of the simple sliding gear type) operated by an extra control lever from the driver's seat. By this means there are provided, controlled in the usual manner by one gear lever, four forward and one reverse speeds of a normal order and range for work on ordinary roads and good "going" (direct drive through the subsidiary box), and four forward and one reverse speeds of a lower order for use on extreme gradients and cross-country work (indirect drive through the subsidiary box).

It has been found practicable in the case of several makes of standard units to bolt the small subsidiary box on to a face machined on the back of the ordinary standard gear-box. It will be clear that this scheme confines all the extra torsional stresses, due to the extra gear reduction, to that portion of the transmission behind the main gear-box—a very great advantage in regard to keeping weight low and using standard power units. The subsidiary box is quite small, light and inexpensive. It is found, in practice, that reductions of between 2 and 3 to 1 are required in this box. Since the subsidiary gear is only in occasional use, and wear is likely to be small, the gears may be kept comparatively narrow. Fig. 4 shows the general lay-out of the transmission.

Worm-driven axles of standard design are used. Owing to the action of the special suspension system the engine and gear-box shafts, and the two worm shafts remain parallel throughout the wide range of relative movement provided. Thus variations in angular velocity are confined to the driving shafts between the gear-box and the first driving axle, and between the first and second driving axles. Both these shafts are comparatively short and carry only pure torque load. They can therefore be made sufficiently strong without being very heavy. But because they are short and the relative movement of the axles is great, the angles through which the universal joints have to act are perhaps abnormal. Special attention is being given to the design of suitable joints to work at these big angles, up to 26 deg., and under heavy loads. Effective lubrication is essential.

Fig. 5 shows the angles which may be reached and indicates the type of assembly and joints which are found to be satisfactory.

Tire Equipment.—Pneumatic tires of the straight-side type are employed for the following reasons:—

(1) Their light weight;

(2) Reduction of shock to the whole vehicle, thereby reducing wear and tear to a minimum;

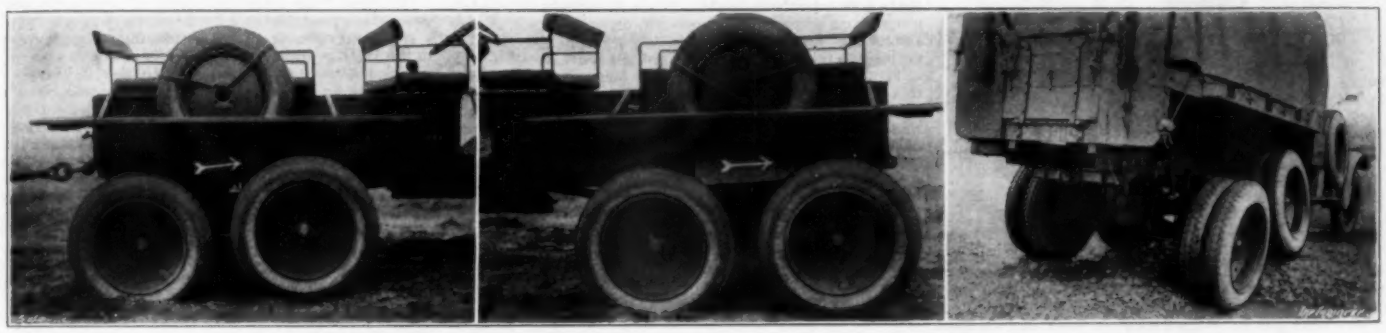


FIG. 2—Result of Rear Suspension in which torque reactions are not balanced

FIG. 3—Free articulation—no disturbance of wheel weights (Karrier "Medium")

(3) Increased area of ground contact, thus reducing sinkage;

(4) Their essential resilience has a great effect in assisting adhesion and reducing rolling resistance on rough, soft and slippery ground;

(5) Their ease of replacement; no tire presses are required;

(6) Their lateral flexibility assists the steering of the vehicle;

(7) The long life and puncture-resisting qualities of the modern pneumatic;

(8) Owing to the small axle loads of the six-wheeler, tires of moderate section can be used.

Item (6) calls for brief consideration. It will be clear that, since in this class of vehicle only the front wheels steer, the tracking of the driving axles must be to some extent imperfect, and some lateral skidding, or other adjustment, between wheel and ground must take place when the vehicle turns out of the straight line. Fig. 6 shows what is meant. Careful investigation indicates that the distance from the front axle to a point about midway between the two driving axles is the effective wheel base on which the vehicle turns.

If the driving wheels be shod with pneumatic tires, pumped to a reasonable pressure, the tires on the first driving axle flex laterally in one direction, and those on the second driving axle flex laterally in the opposite direction, with the result that, provided the adhesion between the treads and the ground is reasonably good, no slip takes place.

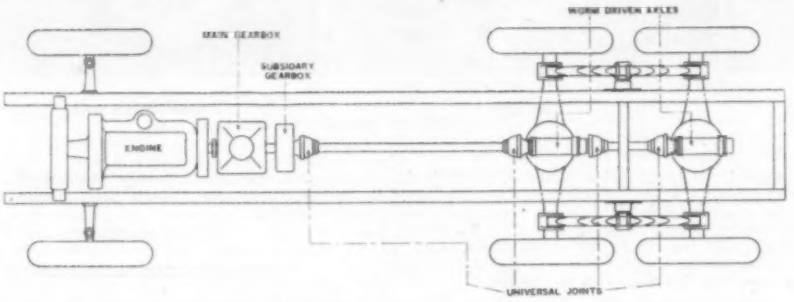


FIG. 4—General Lay-out of Transmission

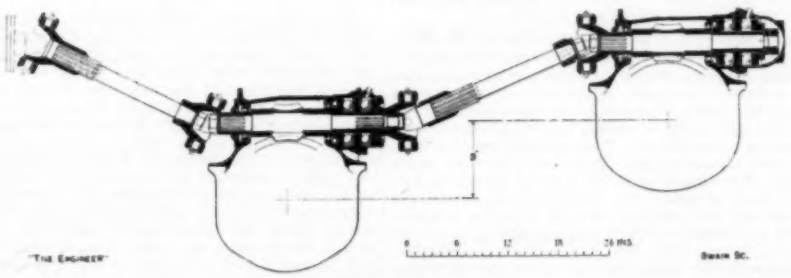


FIG. 5—Transmission Assembly

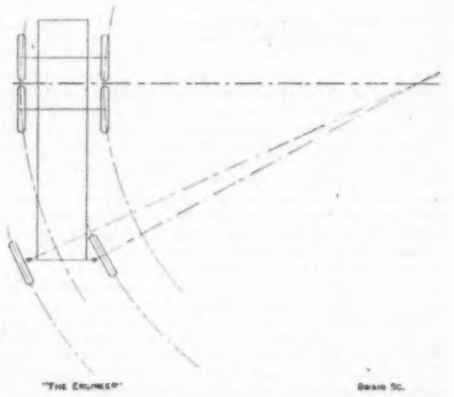


FIG. 6—Faulty Tracking

The amount of lateral flexion, even on full lock, need not be more than that to which such tires are normally subjected, owing to centrifugal force, when an ordinary vehicle swings round a corner.

The imperfection in tracking appears to be quite immaterial as long as the ratio

$$\frac{\text{Distance between centres of driving axles}}{\text{Distance front axle to point midway between driving axles}}$$

does not exceed $4 \div 12{\cdot}5 = 0{\cdot}32$, and the extreme "lock" of the vehicle is not unduly small relatively to the effective wheel base. It will be clear, from the description of the suspension already given, that the free articulation of the wheels ensures almost perfect adhesion between the driving wheels and the ground. Driving wheel slip, when passing over road inequalities at speed, is largely eliminated, and there is no doubt that this more than counterbalances, in regard to tire wear, the slight imperfection in "track" when turning. An increased tire-mile figure results.

For the commercial market some vehicles will doubtless be offered with single tires on all six wheels. For normal W.D. purposes single tires on the front wheels and twin

tires on the four driving wheels are preferred. By this means a larger ground area contact is secured with sizes of wheels and tires which one man can lift and handle for removal and repairs. Also there is a considerable margin of safety against having to stop for tire trouble, in that each of the four driving wheels virtually carries a spare wheel. Furthermore, the W.D. type of overall non-skid chain, in the present state of its evolution, can only be fitted to twin-tired wheels.

The objections to the tire equipment now favoured by the W.D. are the unsprung weight of so many wheels (ten), increased risk of unequal tire pressures, damage to tires

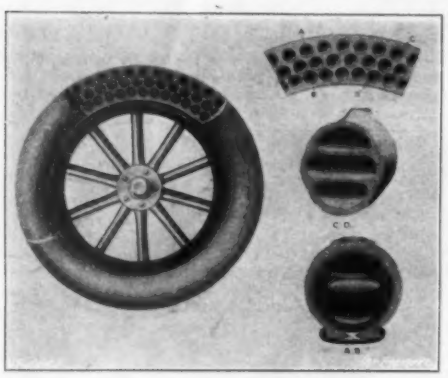


FIG. 7—"V.P." Tube

through stones getting wedged between them, and unequal wear on highly cambered roads. Some of these points can be guarded against with care, and it is worthy of mention that there is a general tendency, in ordinary four-wheeled vehicles, to use twin pneumatic tires of large size (up to 3ft. or more of total tire width in some cases). At the same time it is fortunately the case that modern road construction tends towards less and less camber.

The resistance to acceleration of so many wheels may be reduced in the future by the use of aluminium alloys instead of steel for wheel construction, and, it may be hoped, by lighter tires. It has been noticed that the very few punctures that are experienced occur mainly in the tires of the third axle. This may be pure coincidence, but may, on the other hand, be due to the manner in which stones, nails, &c., are thrown back by the tires of the second axle close in front. Tests are being carried out, in this connection, with a guard between the second and third wheels in the form of a hanging flap which just clears the ground.

New Tire Developments.—There have come under the notice of the W.D. several new types of inner tube designed to avoid, without loss of resilience, that bugbear of the pneumatic tire—rapid deflation when cut or punctured. One such design is now under test with promising results, and the development of others is being carefully watched. The importance of this point on active service is self-evident, and it is hoped that successful development on a manufacturing basis may follow eventually.

As an example there may be mentioned the French "V.P." tube having hermetically sealed air compartments (Fig. 7).

Another recent development relates to the tread design of outer covers. The greatest obstacle in the way of obtaining a good cross-country performance from the wheeled vehicle lies in the difficulty of securing driving adhesion between tire and ground when the surface is soft and slippery. It is natural that the treads of tires destined for commercial use on good roads should be designed with the primary object of securing long mileage life.

The Dunlop Company has, at the request of and in collaboration with the W.D., produced a tire with a tread designed with the primary object of securing maximum adhesion on slippery ground. The tread has cross bars of helical form, and preliminary tests show a distinct improvement in tractive adhesion, compared with the standard tread (Fig. 8). Tests are now being made to ascertain the mileage life of this tread under varied road and cross-country conditions. It is hoped that a demand for such a tire for export may assist provision to meet the needs of the W.D.

Tire Pressures.—It may be stated generally that the result of extensive trials across country has established the fact that the lower the air pressure the better is the cross-country performance. At the same time it is felt that the risk of puncture is too great to enable the low-pressure tire to be used, owing to the fragility of the flexible covers used with this system. The best all-round results are achieved in practice by using the stout covers, designed for moderately high pressure, loading them lightly and inflating them to comparatively low pressures.

Overall Non-skid Chain.—Attention has been directed towards finding the best form of non-skid device to enable progression to be continued when adhesion between tires and ground ultimately fails.

The principal desiderata are :—

(1) Quick fitting ;
(2) Low cost ;
(3) Ease of production ;
(4) Light weight ;
(5) Ready adaptability to a vehicle of commercial type, *i.e.*, no special permanent fittings necessary on the vehicle.

In the case of four-wheeled machines in use by the W.D., whether two or four-wheel drive, what is known as the "bracelet" chain (Fig. 9) has been found the most satisfactory. On the other hand, the efficacy of this type of chain is frequently in doubt. While it undoubtedly assists progress on some types of ground, on other kinds it only assists the wheels to "dig in" more rapidly. It does nothing to increase the area of ground contact.

The six-wheeler suggested a new form of non-skid, and this was first made and tried at Aldershot some twelve months ago. It is known as the "overall non-skid chain." The general idea of this chain will be quite clear from the illustrations, Fig. 10, which show the original pattern having cast shoes, and the latest pattern having steel plate shoes made of lengths cut up out of a cheap rolled section. The connecting links are very cheap stampings. It will be seen that twin tire equipment is necessary, but experiments are in hand at the R.A.S.C. Experimental Establishment with a view to perfecting a chain to run on single tires. Although the W.D. has a considerable number of vehicles equipped with these chains for emergency use, the design must still be considered to be in the experimental stage.

The following points are not always apparent at first sight :—

(*a*) Since both wheels drive the chain is not normally in tension to the extent of the tractive effort of the vehicle, as is the case with a proper track.

(*b*) No initial tension is necessary. The drive is obtained by virtue of the weight of the driving wheels running over the shoes in contact with the ground.

(*c*) The pitch of the shoes is immaterial since no sprocket drive is involved. It is advisable, however, to pitch the shoes so that when one wheel is riding over a shoe the other wheel on the same side of the vehicle is between two shoes. This assists smooth riding of the vehicle if run on ground that is inclined to be hard with the chains fitted, because the bogie rocks as the wheels pass over the shoes, thus imparting very little movement to the frame.

(*d*) One or more points of wide adjustment can be provided, and there is no close limit to the wear of the pins. Thus the life of the chain is longer than is at first apparent, and it is very cheap to produce and replace.

(*e*) In addition to giving increased adhesion the chain gives greater area of ground contact and reduces sinkage.

(*f*) Fitting of a pair of chains takes no more than two to four minutes. They are either laid on the ground behind and the vehicle backed on to them, or they are dropped on to the top of the wheels, the vehicle being then run forward on to the chains. The ends are joined up with a simple hook which can only be undone when the chain is straight. The chains behave in general very well, but they have been designed for occasional and not continuous use, and are intended only to help the vehicles, which have an exceptional performance without any non-skid device, to negotiate the more extreme obstacles. When fitted with the chains the vehicles have a performance comparable with that of the half-track machine.

Development and Production.—As far as is known there was not, in the early part of 1925, a single vehicle of this type in production in this country, but the experiments and investigations carried out by the W.D. had been so promising that it was determined to try to get manufacturers interested. Some enterprising firms, who already held the W.D. certificate for the subsidy type 30-cwt. lorry, were persuaded to take an interest in the matter, and two of them each built a vehicle. These pioneer efforts were moderately successful, but it was felt that improvements could be made.

Later in 1925 the W.D. published provisional specifications which incorporated for the first time a description of the W.D. principle of suspension. More firms became interested and orders were placed with four firms (including the original three) during the financial year 1925–26 for one sample machine each to these specifications. The first trials were held in April, 1926, and most successful results were attained.

There followed a period of intensive testing and trial. Faults were discovered and rectified, more machines were acquired, and it was possible, by means of the most strenuous endeavours on the part of all concerned, to secure sufficient machines to fit the new type of vehicle into the Army field organisation for trial on quite a workable and considerable scale during the Brigade and Divisional Exercises in August-September. Space does not permit of a description of all that took place during that period, but the results were highly satisfactory. Every opportunity was taken to bring the new vehicle to the notice of those whose influence might assist its development. Whoever had the opportunity of seeing the cross-country performance of the vehicles and their remarkable behaviour on the road became enthusiastic. The result at the moment of writing (December, 1926) can be stated briefly :—

(*a*) The W.D. and other Government Departments have received delivery of about 120 machines of the new type and have about 150 on order.

(*b*) Four firms have this type of vehicle in standard production ready for sale for home and export.

(*c*) About eight or nine other leading firms are interested in the W.D. proposals. Several of them have experimental vehicles actually in production to the W.D. order and specification ; others are designing and constructing vehicles to test themselves, or are actively interested in the problem in varying degree.

(*d*) Vehicles are already in successful operation in Government and civilian ownership in India, South Africa, Egypt, the Sudan, and Persia.

(*e*) A number of leading firms have bought and are operating vehicles in this country.

(*f*) Manufacturers have sent samples to their agents in most parts of the Empire.

(*g*) A considerable number of omnibuses and passenger vehicles of the rigid-frame six-wheel type, but, of unfortunate necessity, not entirely conformable to the needs of the W.D., has been produced and these vehicles are in successful operation in public service in many parts of the country.

It may be thought that the development has been over-rapid, but the intensive and continuous nature of the trials carried out, and the enthusiastic co-operation of the manufacturers has enabled much to be done in a comparatively short time.

There seems every reason for confidence that this phenomenal progress, even though the start was late compared with that of our foreign competitors, has created a solid basis for a new phase of development of the British motor vehicle.

(To be continued.)

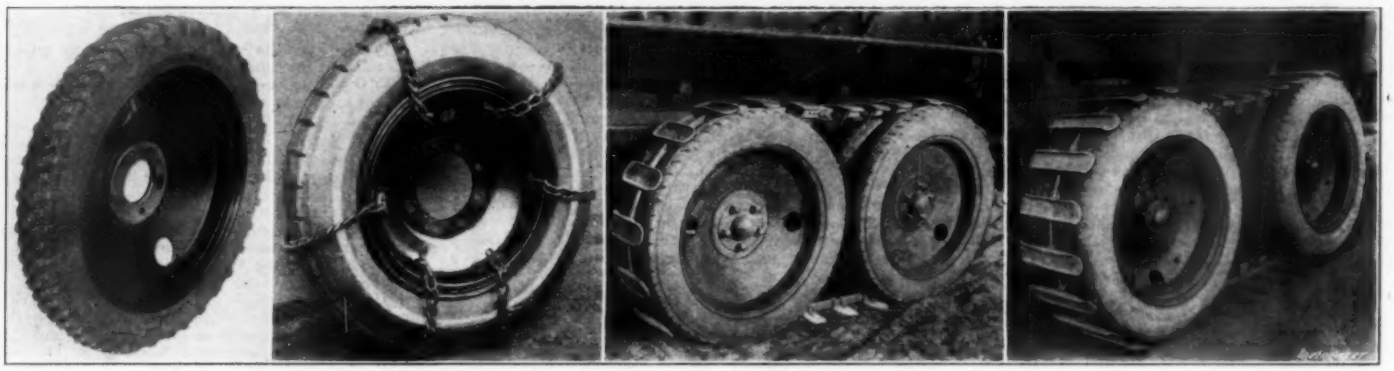


FIG. 8—Self-clearing Tread for Cross-Country Work (Dunlop)

FIG. 9—"Bracelet" Chains

Cast Shoes

Rolled Section Shoes

FIG. 10—"Overall" Non-Skid Chain

COPPER CONDUCTORS FOR ELECTRIC POWER AND LIGHT.

An addition to the British Standard Specification No. 7, 1926, has recently been made by the inclusion of data relative to a twin flexible cord, the conductors of which are insulated with pure and vulcanised india rubber, twisted together and sheathed overall with tough-rubber compound. This flexible cord is intended for use only with pendant electric light fittings on voltages up to 250 volts. In so far as the size of conductor is concerned, this is not a new conductor, it being already included in the table of flexibles, but it is a new flexible in the sense that it is provided with a coating of cab-tire sheathing. A covering of this description has been found quite suitable for use under the circumstances referred to. The details of this flexible cord are given on an addendum slip, which will be issued with all copies of B.S. Specification No. 7, 1926, sold in future. Those already in possession of a copy of the specification can obtain a copy of the slip free of charge by sending a stamped envelope to the Publications Department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1.

Since the note in last week's Seven-day Journal was written, official confirmation as to the transfer to Heysham of the Belfast boats now running from and to Fleetwood has been received from the London, Midland and Scottish Railway. Sir Josiah Stamp has informed the Fleetwood Council that the change is being made coincident with the introduction of the larger and more up-to-date vessels now under construction in order to concentrate the Belfast service on Heysham and to avoid the larger capital expenditure which would otherwise have been involved. It was considered by the railway company that the course would afford greater room for the development of the various growing activities of Fleetwood.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Position Unchanged.

THERE has been little change in the general situation in the iron and steel industries of the Midlands and Staffordshire during the week. No expansion of buying has developed, the tendency being to put off the placing of small orders till the last minute, and to postpone big business until more advantageous terms can be agreed upon. Practically no new buying is taking place, the output of the mills and forges going to fulfil old contracts, many of which were taken at prices below present production costs.

Cheaper Pig Iron.

The pig iron industry has received a severe blow by the increasing of blast-furnace coke values a further 2s. per ton. Coke at 20s. at ovens was already stated to be too dear to make pig iron production a profitable undertaking. At 22s. the only course, presumably, left for smelters would be to increase iron prices or to damp down furnaces. Of course, normal production has not yet been reached. Smelters in most cases have only started one furnace owing to the uncertainty of the coke position. In the Midlands probably only half of the furnaces are at work. The output of coke, however, is expanding, and easier conditions may be expected in the near future. Midland smelters are not only continuing production under present difficulties, but a number of them, in an effort to attract business, have reduced quotations half a-crown per ton. Some Derbyshire furnacemen who have hitherto been quoting £4 5s. at furnaces for No. 3 foundry are now accepting £4 2s. 6d., and Northamptonshire foundry grades are now offered at £4. The reduction has not been made by all Midland furnaces, but those quoting the old prices of £4 5s. and £4 2s. 6d. for Derbyshire and Northamptonshire respectively are in the minority. East Coast hematite is also cheaper, mixed numbers being procurable at £4 6s. 6d. at furnaces. Values of forge grades are unchanged.

Steel.

Apart from structural steel, the market is comparatively inactive. A great deal of business which is usually given out at this period of the year is being withheld owing to the uncertain market conditions, consumers buying only from hand to mouth. Most of the mills engaged on old contracts are being pressed for deliveries, and when it is possible to execute a small urgent order for prompt delivery this is being done. Structural engineers have a fair amount of inquiry, mainly for small tonnages, but they still have difficulty in obtaining supplies. It is anticipated that the good shipbuilding contracts placed recently will bring activity to Midland steel mills later on. Values remain very firm. Mills which accept forward contracts for angles at £7 17s. 6d. require in some cases as much as £8 5s. for quick delivery. Local re-rolling mills are not working up to capacity, and order books throughout the whole of the steel industry could well do with being added to. Continental prices continue to advance, being 1s. to 2s. higher than a week ago. Business in steel scrap at £3 5s. delivered South Wales is very restricted.

Finished Iron.

In the Staffordshire finished iron trade conditions remain stagnant. There is a certain amount of activity in marked bars, and special grades of iron required for exacting engineering requirements, but new business is slow in coming forward, and its bulk is disappointing. More iron is being absorbed by the Black Country chain, cable, and anchor trades, and the improvement in the lighter engineering trades is helping the market to some extent. Lancashire houses continue their efforts to secure the Crown bar business, but it is not much which goes to anyone just now. Business in native common bars is at a standstill. Belgian No. 3 iron, which corresponds with the Staffordshire common bar, is now £6 5s., as compared with £6 2s. 6d. a week ago. It is, however, still £4 10s. below local makers' prices. There is a fair demand for iron tube strip, the price of which remains at £13 5s.

Galvanised Sheets.

In the galvanised sheet trade a little more inquiry is evident both on home and foreign account. Quotations for 24-gauge galvanised corrugated sheets range from £15 for a good order, to £15 2s. 6d. Few substantial orders are forthcoming, however, tonnages being small all round.

Increasing Output.

That iron and steel are going ahead is amply proved by the records of output during the past month. That steelmasters should have turned out 819,100 tons of steel ingots and castings—equal to an annual rate of 10,648,300 tons—under existing circumstances is indeed much to their credit. This output compares with 730,700 tons in January, 661,000 tons in April, 1926, and 703,800 tons in February, 1926. Midland industrialists, moreover, were pleased to learn that a further ten blast-furnaces had been recommissioned during the month, bringing the total to 162, or 15 more than were operating before the coal stoppage in April last year. Considering the poor demand last month for both forge and foundry pig it is somewhat surprising to find that the production of pig iron during that period amounted to 567,900 tons, compared with 434,600 tons in January, 539,100 tons in April, 1926, and 502,000 tons in February, 1926. The production included 194,600 tons of hematite, 187,700 tons of basic, 142,900 tons of foundry, and 17,500 tons of forge pig iron.

Birmingham Exchange.

Mr. A. E. Bond, who presided at the forty-seventh annual meeting of the Birmingham Exchange on Thursday of last week, gave an interesting review of trade conditions in the past year, and spoke hopefully of the industrial outlook. There were, he thought, distinct signs of trade improvement in many directions. A remarkably rapid recovery was noticeable in the British pig iron industry, and the total of 152 furnaces now in blast was five more than before the stoppage last year. Shipbuilding and other heavy trades at the present time had more orders on hand than for a long time, and the orders received at the British Industries Fair were most encouraging. He pointed out that for the development and extension of British industries a plentiful supply of cheap fuel was essential, and so far as the coal owners were concerned, he was optimistic enough to believe that they would "deliver the goods." The annual report and statement of accounts were adopted, on the proposal of the chairman, seconded by Colonel Trinham. A vote of condolence was passed with the widow and family of the late Mr. F. C. Ryland, who was a member of the Committee for twenty-two years and President from 1919 to 1925.

Suggested Scheme of Alliance.

Midland iron and steelmasters are not enamoured with the prospect of a powerful British–French–German trade combine in iron, coal, steel and potash, which this week has been reported as a possible result of the visit to this country of Herr Rechlerg, the distinguished German industrialist and financier, who was instrumental in the formation some years ago of the important Franco–German trust in potash, and subsequently the alliances between France and Germany in iron, coal and steel. Industrialists hereabouts, at the moment, reserve their opinions of the advisability or otherwise of such a pact, but they do not hesitate to express the view that the prospects of an alliance are not great.

Midland Colliery Agreements.

Agreements have now been signed by the representatives of the colliery owners and of the miners in the Leicestershire coalfield and the South Staffordshire and East Worcestershire field. In the latter district the agreement will operate until June, 1931. There will be an eight-hour day for men underground, and a 48½-hour week for surface workers. Wages are to be at 57 per cent. on basis rates until the end of March, and for April, May and June there will be a percentage at the discretion of the owners of not less than 47 on basis rates. The wages in July are to be based upon the ascertained results of March, April and May, and subsequent ascertainments will be on similar lines. The minimum wage will be 40 per cent. on basis rates. The Leicestershire agreement provides for an eight-hour day and a 5 per cent. reduction of wages on the basic rates on April 1st. The percentage on the basis will then be 60, and that figure is to continue to the end of June, when there will be a further ascertainment.

Black Country Mines Drainage.

It is believed that as a result of a conference last week the critical position which had arisen recently in connection with the working of the Windmill End and Buffery mines drainage pumps, the ceasing of which would bring disaster to the Black Country mining industry, has been averted, and that there will shortly be a satisfactory settlement of the whole difficulty. The reserve of minerals in the whole of the area five years ago was officially stated to be 38,500,000 tons of coal, 55,250,000 tons of fireclay, and over 1,000,000 tons of ironstone; and as this mineral wealth has not been appreciably decreased since then it will be realised how serious would be the loss to the owners, as well as to the miners numbering about 3000, and the industries of the district generally if the area should become water-logged by the stoppage of the pumps. Representatives of the Old Hill Mines Drainage Committee, the Buffery Colliery Company, and the colliery proprietors have again discussed the financial difficulties, and a scheme which it is hoped will prove acceptable to all parties has been formulated and now awaits ratification.

Derbyshire Pit Management Scheme.

The Bolsover Colliery Company, Derbyshire, with a view to securing a better understanding with its workmen, proposes to ask the miners to elect consultative committees to work in co-operation with the managements of the company's pits, to secure the more efficient working of the mines, to insure the highest degree of safety and to bring about the best possible conditions of working the pits. There is every possibility of the scheme being taken up by the Clipstone miners, who have received the company's announcement with considerable pleasure as tending to improve further the relationship existing between employer and employed.

Work for Birmingham.

I understand that the thirty first-class day and sleeping saloons recently ordered by the South African Railways and Harbours Administration, Johannesburg, from the Vickers Metropolitan Carriage, Wagon and Finance Company—South Africa—Ltd., are to be constructed at the Saltley Works, Birmingham.

Unemployment.

The rapid decline in the number of persons unemployed in the Midland area continues, and last week a further 4190 workers were re-absorbed into various industries, bringing the total unemployed down to 133,436. Of this total 99,332 are men, 28,822 women, 3338 girls and 1944 boys. The number on the live register of the Ministry of Labour for the Birmingham area now stands at 27,770; Coventry, 2316; and Wolverhampton, 4895. There is stated to be every sign of the improvement being maintained.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery Exports.

ALLOWING for the shorter working period, exports of textile machinery in February were not much below those of the previous month, though there was a substantial reduction compared with the corresponding month of the two preceding years. The total value of the exports in February was £825,000, of which £651,000 represented shipments of spinning and twisting machinery, and £125,000 exports of weaving machinery. Russia has again advanced to first place, with shipments valued at £189,500, the British East Indies being deposed to second place with £141,300, that figure comparing with over £200,000 in January. Reductions in exports are shown in the case of pretty well every market, France, apart from Russia, being the only exception. France was the largest individual market, following Russia and the East Indies, shipments thence during the month under review being valued at over £62,000. South America came next with £58,000, followed by the Netherlands with £44,300, Germany with £40,200, the United States with £33,300, Japan with £30,800, China with £25,100, and Australia with £17,532, "other European countries" taking shipments of an aggregate value of £133,800.

A New Ship Canal Bridge.

A proposal is afoot for the construction of a new bridge over the Manchester Ship Canal between the existing swing bridges at Trafford-road, Salford and at Barton, which are several miles apart. A preliminary conference has already been held between representatives of the Manchester Ship Canal Company and of the Trafford Park Estates Company, and the surveyors of the various local authorities concerned. There was general agreement with the proposal to erect a new high-level bridge, though the Ship Canal Company and the Trafford Park Estates Company do not favour the position that has been provisionally selected, on the ground that it would interfere with the development of their estates. A further conference of local surveyors, to be followed by a conference at which their findings will be considered by representatives of interested authorities and individuals, has been arranged.

Ultra-Violet Rays in the Factory.

An interesting social and industrial experiment has been undertaken by Ferranti, Ltd., of Hollinwood, near Oldham. The firm has used in the windows and skylights of its new extension at Hollinwood about 33,000 square feet of "Vitaglass," the chief virtue of which is that it is transparent to the ultra-violet rays of the sun. About 400 employees of both sexes, a large proportion of them under the age of twenty-one, will occupy the new building. Although "Vitaglass" has been employed in connection with hospitals in various parts of the world, and, of course, in the well-known case of the London Zoo, its use in connection with an industrial undertaking is said to be novel. The practical results of the experiment are to be very closely observed, and it is hoped that a period of twelve months will furnish sufficient data to enable a comparison to be made between the health and efficiency of the workers employed in the extension and of those who remain at the old works.

Industrial Results.

The annual report of British Insulated Cables, Ltd., Prescot, discloses a reduced profit for last year, the figure being £607,853, compared with £670,300 in 1925, though the dividend of 15 per cent. on the ordinary shares is again being distributed. The directors have transferred £200,000 to the reserves, compared with £333,333 in the previous year, and £271,721 is carried forward, against £224,918, allowance for depreciation being £85,000, compared with £75,000 in 1925. The influence of the coal stoppage on the activities of the English Electric Company, Ltd., Preston, is reflected in the announcement of the directors during the last few days that they have decided not to pay the dividend on the 6 per cent. preference shares for the half-year ended December 31st last.

Local Contracts.

The contract for the whole of the condensing and auxiliary plant for the Birmingham Corporation's new Hams Hall generating station has been placed with Hick, Hargreaves and Co., Ltd., engineers, of Bolton. A recent Berlin message stated that the order for the plant and machinery for the new Branston artificial silk factory, near Burton-on-Trent, had been placed with the Kohorn Textile Machinery Company, of Chemnitz. This is contrary to the facts. John Hetherington and Sons, Ltd., of Manchester, have secured the contract, valued at £361,000, from the Branston Company. Messrs. Hetherington, some twelve months ago, acquired the rights to manufacture Kohorn artificial silk machinery throughout the British Empire, and the plant for the Branston factory, as stated in the company's prospectus, "is to be installed in co-operation with Messrs. Kohorn and Co." An official statement of the Manchester firm says that the position is unchanged, and that they still hold the contract.

Non-ferrous Metals.

Apart from copper, which has given way a little compared with last week, the other non-ferrous metals have maintained the improvement reported in these columns a week ago, though there has been no further advance. Certain bearish influences affected the tin market during the week, and there was a series of rather violent fluctuations. On balance, however, as already stated, there is little actual change in values at the time of writing compared with those current a week ago. Sales have been on a more restricted scale than in the previous week, and stocks in this country have shown an increase. Buying of copper, both in the United States and in Europe, has been less in evidence, and this fact, coupled with a

certain amount of realising, adversely influenced values. Some recovery has since taken place, and at the moment the spot and three months' positions are about 10s. lower than they were at this time last week. Spelter, on balance, shows a very slight improvement compared with last report, and with a rather better undertone the market remains fairly steady. Lead declined at one period on heavy offerings from the Continent, but prices finished up pretty well where they were. Buying of this metal is on a moderate scale.

Iron.

There has been a decided weakening of pig iron prices during the last few days, but there is by no means any sign of a break, the maximum extent of the decline being about 2s. 6d. a ton in each case. In view of the higher coke prices that makers will have to face at the beginning of next month, some of them are maintaining the quotations that were previously in force, but they are exceptional cases, and it is extremely probable that their prices also will be reduced before long. Derbyshire No. 3 foundry iron is now on offer at about 90s. 6d. per ton delivered in the Manchester district, with Middlesbrough at 92s. 6d., Scottish at 105s. to 107s. 6d., and West Coast hematite at 97s. There has been no perceptible improvement in the extent of buying operations, however, although in some instances it is reported that the lower values have had the result of bringing out a little extra business that had been held back during the last few weeks in anticipation of the fall. Most of this has been for early delivery, and contract orders are still conspicuous by their absence. Lancashire bar iron is unchanged at £11 15s. per ton delivered for Crown quality, and £10 15s. for seconds, but there is still only a very quiet trade being done.

Steel.

Here and there it is possible to place orders for ship and tank plates at the Association minimum, but in these cases special conditions obtain, and with order books of most steel rolling mills still fairly well placed, the majority of them are maintaining their prices, particularly for early delivery. It remains a patent fact, however, that users are content yet to hold off so far as any large-scale commitments are concerned, for buying is largely limited to spot or early delivery parcels. Boiler plates are well held at about £11 10s. per ton, ship and tank plates are usually quoted at £8 15s., joists and sections at £7 17s. 6d. to £8, basic bars at about £9, special and ordinary acid wire billets at £12 10s. and £11, and forging blooms at £9 10s. per ton, delivered in the Manchester district. There is very little call for small re-rolled bars, and Lancashire makers are offering these at £8 15s. to £9 per ton. In spite of a very restricted demand, prices of imported steel continue to show increased firmness in almost every instance, wire rods being the one exception. For delivery into this area, for cash against shipping documents, steel bars are now quoted at £6 5s. per ton, sheet bars at £5 15s., billets at £5 10s. to £5 12s. 6d., joists at £6 5s., ordinary plates at £7 7s. 6d., and Siemens plates at £7 12s. 6d. Wire rods are a trifle easier at £6 4s. to £6 0s. per ton, owing to keen price cutting between the continental makers, and rather more activity has been displayed in this section than in any of the others. Indian interest in galvanised sheets has again dwindled, but values here are about maintained at £15 per ton f.o.b., for the usual specifications for that market. Thin gauges are also held at recent rates, but there is little buying of these for the Eastern markets just now.

Scrap.

Values of non-ferrous scrap keep fairly steady, and a moderate amount of business is being put through. Brass rod turnings, for sorted qualities and including delivery to users' works, are quoted at about £40 per ton, with heavy yellow brass at £45, clean light copper at £57, zinc at £25 10s., lead at £26 10s., and selected gun-metal scrap at about £52.

BARROW-IN-FURNESS.

Hematite.

The position in the hematite pig iron industry remains the same. Makers are very busy trying to satisfy the demands of their customers, who are keen for deliveries, but all this iron was ordered some time ago—before the re-start—and what many are debating is the hesitancy on the part of buyers to place further orders. In other words, iron is being delivered in a much bigger tonnage than orders are now being received for, and one of the reasons for that is said to be the hope on the part of consumers that iron will become a little cheaper. That remains to be seen. In the meantime, makers are not short of work, and are assured of being able to continue with present contracts for another four months or so. A considerable amount of iron produced is proceeding seawise, coastal and abroad. The demand for special qualities of iron continues to be brisk and manganese is experiencing a good market at home and abroad. As regards steel, while the works have plenty of orders to deal with, fresh orders are not coming in to take the place of those completed. This state of things may improve as regards rails, &c., and with respect to small sections and hoops a good future is assured. Iron ore is in steady demand, and one may gather some idea of the future of the iron trade from the fact that boats carrying foreign ore have been chartered for cargoes over the next eighteen months or more.

Electricity.

The Barrow Corporation is not having its own way with the Electricity Commissioners. Its scheme to harness the Backbarrow Falls on the river Leven was turned down, much to the regret of many, for it was argued that there was valuable power going to waste which might help the district supply. Then the Barrow Corporation sought powers to extend its present power station at a cost of about £60,000, it being argued that it could produce cheaper power than that Vickers could supply to the town from their large modern power station. The Commissioners are adamant, and up to the present no local argument has caused them to alter their decision. If Barrow does not get powers, it means that the town will have to take energy from Vickers at a rate to be fixed at a conference.

SHEFFIELD.

(From our own Correspondent.)

Steel Production.

THE trend of my weekly reports as to the activity of the heavy steel trade of this district since the end of the coal dispute is borne out by the returns of steel production in January, which are now available. These show that the total output in the Sheffield district was 110,000 tons, a figure which exceeds that of January last year by 22,000 tons, and is above the monthly average over several years. The total included 8000 tons of crucible steel and castings, and all the rest was steel melted in open-hearth furnaces. There was a larger output of basic steel than of acid. The production in Lincolnshire was about the same as that of a year ago. The conditions which have been indicated during the last few weeks continue with little or no change. The open-hearth plants of Sheffield and district are still working almost up to their full capacity, making allowance for the periodical necessity of stopping furnaces for repair. While, however, there is enough work on hand to keep them going for another five or six weeks, new business is still not coming forward in the bulk quantities that are desired. Orders are evidently being held back until prices fall, but the first step in this movement—a reduction in pig iron—seems as far off as ever. The dearness and scarcity of blast-furnace coke is at the bottom of the matter. As the result of the lengthy stoppage, the coke ovens suffered badly, and it has been a much slower and more expensive matter to get them into order again than was anticipated.

At the Rolling Mills.

Only a moderate amount of employment is being enjoyed by the local rolling mills, and they report a scarcity of work for the export trade. Many of the orders coming to hand are of small bulk, so that for the most part rolling is unremunerative. Continental competition in the steel trade is growing. There have lately been large importations of foreign material at prices substantially lower than those at home. Foreign billets are also much more plentiful than British. Not much of this steel comes to the Sheffield district. The largest buyers are the re-rollers in the Midlands, and they report that it answers their purposes fairly well.

Some Company Results.

Three local companies have during the week made announcements as to the results of their past year's trading, and, as was only to be expected, they are for the most part far from pleasant reading. The report of Cammell Laird and Co., Ltd., shows a loss, after charging full depreciation, of £73,575. After transferring £50,000 from the reserve account, there remains a credit balance of £1462. The reserve fund still stands at £600,000. No dividends are recommended on either preference or ordinary shares. For the previous year the loss amounted to £36,381, and the figure now reported is no doubt mainly attributable to the long coal stoppage. Henry Bessemer and Co., Ltd., who made a loss of £1307 in 1925, report a net loss for 1926 of £27,667. The report states that the year opened with a good order book, and during the first four months a profit was earned. The reorganisation of the works in Carlisle-street, Sheffield, was completed in April, but the general strike and the coal strike prevented any advantage being obtained from the more economical working of the new tire plant. The works were idle from May to December, with the exception that a few tires and axles were manufactured at a loss in order to retain the goodwill of customers. Hadfields, Ltd., has made an announcement which is more satisfactory to its shareholders. It is able to pay an ordinary dividend of 2½ per cent., less tax, as compared with 3 per cent. last year. The full report on the year's working has not yet been issued.

Cutlery and Plate.

February is not usually a busy month in the cutlery and plate trades, but this year it was below the average, and, as there is no sign of the customary spurt before Easter, it does not appear probable that March will register any improvement. Only in one or two cases have the Sheffield exhibitors at the British Industries Fair reported that they booked any substantial amount of business. The depression in these trades is attributed to a good many causes. Some people are unable to afford re-equipments of cutlery and plate because of the growth of the motor habit, and the cost of its maintenance; others find their spending power reduced because of the effects of the coal dispute, and the absence of dividends from industrial investments; while others do not need such supplies as formerly because of the spread of the practice of taking meals at restaurants and cafés instead of at home. Reports on the falling-off of trade from this country to South America are confirmed by the cutlery industry of Sheffield. Its shipments to that Continent last year were below those of previous years, although not to any serious extent. During the last month or two a noticeable drop was seen in South American purchases of Sheffield matchetes and other plantation tools.

New Gas Plant Contract.

A good contract reported this week is one which Koppers Coke Oven Company, Ltd., of Sheffield, has secured from the Chapel, Whaley Bridge, and District Gas Company for the supply of a continuous vertical chamber oven plant. This type of oven is designed on the reversible regenerative principle, and is heated by gas generated in outside producers. Plants are operating in Holland and Germany, but the one now ordered will be the first of its kind to be erected in this country. It will consist of two units, each of two chambers. Each chamber will deal with 12½ tons of coal per day, and the plant as a whole will be capable of producing 800,000 cubic feet of gas per day. The ovens will be heated by producer gas generated in outside producers of the Koppers type, two of which are to be supplied under the contract. The plant will be encased in concrete. Many advantages are claimed for the continuous vertical oven, including high-speed carbonisation owing to the thinness of the charges of coal, high yield of gas, low fuel consumption, owing to use of outside producers in combination with reversible generators, absence of "sticking" of the charge, and reduced cost of fuel owing to employment of coke breeze and low grade fuel.

A Pick-sharpening Invention.

A labour-saving device which is of special interest to the mining industry has just been introduced by the Hardy Patent Pick Company, Ltd., of Sheffield. It is a machine for hammering out and re-sharpening blunted or broken pick points—an operation which has hitherto been done by hand by the colliery blacksmith. It consists of a hammer driven by compressed air and controlled by a foot pedal. It is compact in shape, and the hammer operates at the height of a man's hand so that bending is obviated. Only a single heat is necessary for the dual process of hardening and sharpening, which is completed in the short time of about five seconds, or one-third of the time occupied by the old hammer and anvil method. When picks are badly broken it is necessary to draw the "shoulder" down, and ordinarily this involves a good deal of hard work on the anvil. The air hammer has a raised part under one side which rapidly draws out the metal to the required shape.

Two Derbyshire Finds.

An interesting find of coal at a small depth beneath a main road is reported from Tansley, in Derbyshire. While workmen were engaged in trenching operations in connection with the laying of sewers for a new housing scheme, they struck a seam of coal some 3ft. thick, running parallel with the road. As it is much thicker on one side of the trench than the other, there is reason to believe that it will reach a good thickness on the adjoining land. The coal is described as hard, bright, and exceptionally good. Another interesting discovery in Derbyshire consists of a vein of lead in an ancient mine known as the Jug Hole, near Matlock. The mine had not been worked since 1848, and was believed to be exhausted, but prospecting operations recently undertaken have proved very successful, and a vein of the exceptional thickness of 4in. has been found. Investigations show that it is not a pocket, but a real vein running south-west. Over 15 tons of ore have already been secured, and mining is being continued on a considerable scale.

Developments at Glossop.

Large extensions and developments are projected at Olive and Partington's Turn Lee and Dover Paper Mills, Glossop, which now form part of the Inveresk Paper Company's group of mills. Mr. William Harrison, the chairman of the company, in addressing a gathering of the employees on the occasion of an entertainment given by the management last Saturday, said they were going to equip the mills with the finest plant that British labour could produce, and the expenditure would not be less than £100,000.

From Thorne to Goole.

The proposed construction of a railway from Thorne Colliery to Goole, and a wharf on the Ouse, by Pease and Partners, has been approved by the Parliamentary Committee of the Hull Chamber of Commerce. A resolution was passed in which it was stated that the scheme "may be the means of facilitating the export of coal from the Humber, and is therefore worthy of support, provided always that the construction and use of such a wharf shall not in any way interfere with the navigation of the Humber."

NORTH OF ENGLAND.

(From our own Correspondent.)

Record Steel Outputs.

RECORD outputs of steel are being made at many of the steel-producing plants in the North of England. At one of the works on Tees-side, an average of 6000 tons of steel is being turned out weekly as the result of a system of intensive production, whereas formerly the weekly average was about 4500 tons. At practically all the works full capacity output is being maintained, but still manufacturers are unable to cope with the requirements of their customers. As a result, constructional work is being held up in many directions. Shipbuilding and engineering establishments are clamouring in vain for more and more materials, and in many instances operations are having to be curtailed.

Cleveland Iron Trade.

The Cleveland ironmasters took an important step this week when they abolished the export premium of pig iron which has been in operation for some considerable time past. It would seem that the time has now arrived when the ironmasters are in a position to make an effort to capture some of the last export trade. Hitherto, they have been largely engaged in supplying the needs of the local steel works and in overtaking arrears of deliveries under old contracts. But they now need fresh orders to ensure continuity of operations, and as prices were too high to attract consumers, the ironmasters have not only abolished the export premium, but have reduced quotations by 2s. 6d. per ton. The export premium has long been a source of irritation to shippers, and, as buyers abroad can only be attacted here by low prices, it only had the effect of raising another barrier to foreign business. Cleveland, however, can never be wholly prosperous without a healthy export trade, and the abolition of this irksome charge is

therefore to be welcomed as a step in the right direction. The desire for more foreign trade, however, will not be easily satisfied. The reduction in price may bring in a few orders, for there are consumers abroad willing to pay a reasonable extra sum for Cleveland iron; but Cleveland is still far from having reached competitive figures. No. 3 foundry iron is obtainable at, f.o.b. Antwerp, 70s. to 72s. 6d., and iron is still being brought into the Tees at less than the f.o.t. price of No. 3 Cleveland. Nor are the home buyers keen on placing orders at 80s. It is still contended that the figure is too high, and whilst a few orders may mature, consumers seem inclined to continue purchasing on a hand-to-mouth basis, having no difficulty in getting prompt delivery whenever they place an order. The current quoted prices are:—No. 1 Cleveland foundry iron, 82s. 6d.; No. 3 G.M.B., 80s.; No. 4 foundry, 79s.; No. 4 forge, 78s. 6d. per ton.

Hematite Pig Iron.

The demand for East Coast hematite pig iron is on only a moderate scale, and though makers have a fair amount of work in hand, they are, in their anxiety to enter into new contracts, prepared to entertain offers below market rates. Competition for new orders is, in fact, very keen, and 86s. per ton now represents an average market price for East Coast mixed numbers.

Ironmaking Materials.

The uncertainty of the outlook in the iron trade strengthens the determination of the ironmasters not to make further ore purchases, and business in foreign ore remains very quiet. Best Rubio ore is nominal at 22s. per ton, c.i.f. Tees. The price of blast-furnace coke is irregular, but with the coal market weak there is undoubtedly an easier tendency. Some of the Durham coke makers still quote 27s. per ton for good medium qualities delivered at the works, but it is possible to buy at 26s. per ton.

Manufactured Iron and Steel.

Manufacturers of finished iron and steel are so busy that new orders can only be accepted subject to delay in delivery, and on that account buyers are not keen on placing orders. The works, however, have enough orders on hand to keep them busily employed for months to come, and prices generally are firm, though black and galvanised sheets are a shade easier.

The Coal Trade.

Business in all sections of the Northern coal trade remains on very quiet lines, and the whole forward position is disappointing. The lack of prompt business gives fitters of many grades no option but to lay idle or at least reduce production by short-time working, and the prospects for the next week or two are anything but bright. The inquiry for April is fairly active, tenders having been asked for 130,000 tons of steam coals for the Belgian State Railways, 150,000 tons of best steam coals for the Swedish State Railways, and 40,000 tons of Northumberland steam coals for the Latvian Railways. There is very keen competition for these contracts, though most of the fitters are reported to be holding for full range values. They declare that they cannot quote lower because of the high costs of production. On the other hand, merchants are insisting that prices must fall, for business is being lost at the prevailing figures. It would appear therefore to be a question of who can hold out longest. Merchants predict that the range of values will fall before long, but as to that there is yet no symptom. Best steam coals direct are 16s. 9d. to 17s., and through second hands only odd coppers' discount is available. Wear primes are a firm market, and scarce at 19s. to 20s. for large and 14s. for smalls. Tyne primes are quiet at 15s. 6d. to 16s. large and 11s. for smalls. Gas coals are irregular, and spot buyers can secure slight discounts. Best Durham qualities are quoted at 17s. 9d. to 18s., and secondary at 15s. 9d. to 16s. Coking coals and bunkers are in moderate request at late rates. The general demand for coke continues active, while all production meets with keen competition and pressure is substantial for early deliveries. The home demand is exceptionally good, and the export trade is slowly expanding. Prices are firmly quoted, gas coke being 23s. 6d., foundry coke 28s. to 30s., and beehive 32s. 6d.

SCOTLAND.

(From our own Correspondent.)

Continued Dullness.

THE steel, iron and coal markets continue dull, so far as fresh business is concerned, and there is no prospect of early improvement.

Steel.

Steelmakers are very hard pressed in order to keep deliveries in line with consumers' demands, but it is significant that new business is not being booked at anything approaching the rate at which existing orders are being overtaken. Steel ship plates and sectional material are in pressing demand, and deliveries fall short of requirements. Prices are nominally unchanged, but are not particularly firm.

Steel Sheets.

Sheet makers are booking plenty of orders, but the demand centres chiefly in the lighter gauges. Both black and galvanised sheets are in request, and some makers are sold for weeks ahead. The spring demand is earlier than usual, and the large deliveries specified are wanted at the earliest possible moment. Heavy sheets are comparatively quiet.

Iron.

The market for finished iron shows no improvement. Orders for bar iron are not sufficient to maintain full employment, and the same may be said of the re-rolled steel departments. The home price of bar iron is unaltered, but Crown quality bars for export have been quoted at £11 10s. per ton and under f.o.b. Glasgow. Re-rolled steel bars are quoted about £8 10s., or slightly less, per ton, home or export.

Pig Iron.

The output of pig iron continues on a restricted basis, but arrangements to increase production are well in hand. Meantime, supplies of hematite are somewhat short. Foundry qualities are fairly plentiful, with the exception of certain brands. Prices show little change, but are barely steady.

Coal.

The situation in the coal trade generally is without improvement, and prospects are obscure. Home demands are still below normal, while in the shipping branch exporters find great difficulty in securing orders in face of keen competition from English as well as foreign fuels, in spite of a continued decrease in prices. In the West of Scotland best splints are, owing to recent bookings for Mediterranean and River Plate destinations, the only descriptions to maintain a degree of firmness. The East of Scotland districts are most keenly alive to the dearth of foreign orders, as the collieries there depend on the shipping trade to a very large extent. Many colliery sidings are blocked with wagons of unsold fuel, and some pits have been closed down, while many others are working three days per week. Many are embarrassed by the fall in prices, and state their inability to make a profit. New business is entirely of a hand-to-mouth variety, and while shipments are fairly well maintained these are almost entirely against old contracts. Aggregate shipments amounted to 233,052 tons, against 222,101 tons in the preceding week, and 220,502 tons in the same week last year.

Coalmining Developments.

The existing depression in the trade has not deterred colliery owners from seizing opportunities to develop new coalfields. On behalf of Mr. S. P. Hodge and others, one of the deepest bores that has ever been put through coal measures in Scotland has just recently been completed at Redyett, Forestmill, near Clackmannan. The bore-hole was started with a 9in. cutting crown, giving a 7¼in. core, and finished at a depth of 563 fathoms, with a 5in. crown, giving a 3¾in. core. The bore has proved the full range of coals in the carboniferous series, and the cores obtained yielded good samples of all the seams passed through. It is expected that steps will be taken to develop the field.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE conditions in the steam coal trade have not undergone a great deal of change of late. There were recently signs of an improvement, and it is a fact that the undertone is better, but the volume of new business has scarcely come up to expectations. Although there has been a fairly substantial amount of outward chartering of late, tonnage is being quickly loaded, with the result that there is no real pressure, and prices, while they remain about stationary, do not receive any impetus in an upward direction. There is no disguising the fact that the conditions have not come up to anticipations, and in view of the fairly good outputs, more business is required to put real life into the markets. In the case of a few particular coals some tightness is being experienced, but for most grades the inquiry for early shipments leaves something to be desired. The Metropolitan Water Board is reported to have purchased recently fairly substantial quantities of large coal from this district for delivery over the remainder of this year, and there are several interesting inquiries about, including one for about 37,000 tons of large coals for one of the Irish railways, while the Swedish Railways are in the market, though it is feared that comparatively little of this business is likely to come to South Wales. What is undoubtedly required is a revival in the home industries, which if they were operating on an active scale would need considerably more coal than they are taking at present. This would mean reducing very materially the amount of coal which now has to find an outlet in shipments abroad.

Cwm Colliery Disaster.

The bodies of the last three victims of the Cwm disaster were recovered last Friday, and were brought to the surface. This makes a total of fifty-two. The systematic reopening of the mine is being proceeded with immediately, the colliery being now clear of gas.

Iron Ore Discovery.

It is reported that a large bed of iron ore, extending from Kenfig to Sker, has been discovered, and that a syndicate has been formed to negotiate for the acquisition of about 500 acres of land for the purpose of exploiting the deposits. According to engineers' reports, the working of this area will be a paying proposition, in which case there is a good prospect of a revival of trade in the district concerned, as Kenfig is within a few miles of the furnaces at Port Talbot, and in the centre of the Pyle and Kenfig Hill colliery area.

Tin-plate Trade.

An appeal by the men's side for a reconsideration of the basis on which the sliding scale operates in the tin-plate industry was made at the last annual meeting of the Joint Board of the Welsh Plate and Sheet Trade, and was met by a suggestion from the employers that the men's representatives should submit an alternative scheme. Since that time the men's leaders have considered various propositions, and in the interval gave three months' notice to terminate the agreement in May, that step being necessary before a new scheme can be discussed. The scale at present is based on the selling price of steel bars, which form the raw material of tin-plate manufacture. The latest suggestion is that the basis shall in future be the selling price of tin-plates, and it is proposed by the men that a joint meeting shall be convened to discuss this scheme.

American Coal Strike.

News has been received at Cardiff that the threatened strike at the end of this month of bituminous miners in America will not take place. It is understood that as the result of negotiations an agreement has been come to of a provisional character to remain in force up to the end of this year.

Coalowners' Commercial Committee.

At the annual meeting of the Commercial Committee of the South Wales Coalowners' Association, held at Cardiff on Tuesday, Mr. F. T. Halford (Messrs. T. Beynon and Co.) was elected chairman for the ensuing year and Mr. T. P. Cook vice-chairman.

Current Business.

Hopes are entertained that this week's shipments will prove better than they were last week, when the total was just over 70,000 tons less than during the previous week. This reduction was due to the shortage of ready tonnage. The position in this respect is more satisfactory at the moment. Values of Admiralty large coals and leading Monmouthshire qualities are well maintained, as they are pretty fully booked for the remainder of this month, but dry descriptions and inferior Monmouthshire coals are rather short of prompt orders, and as a consequence are irregular in price. Smalls are very steady in the case of superior sorts, and washed coals are well upheld. Patent fuel and coke have not undergone any appreciable alterations, but pitwood is much firmer. This commodity is invariably highly mercurial, and at the present time is strong, owing to floods in France, which are interfering with the cutting of timber, with the result that supplies for the next week or so are expected to be curtailed. The price is now about 33s. 6d. to 34s. 6d. ex ship.

LAUNCHES AND TRIAL TRIPS.

PORT HUON, motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Commonwealth and Dominion Line, Ltd.; dimensions, 475ft. 6in. by 63ft. wide; 11,350 tons deadweight. Engines, twin-screw reversible single-acting two-stroke cycle; constructed by the Wallsend Slipway and Engineering Company, Ltd.; launch, March 4th.

CONTRACTS.

HICK, HARGREAVES AND CO., Ltd., of Bolton, inform us that they have secured the order for the whole of the condensing plant and auxiliaries for the new Hams Hall generating station for the Birmingham Corporation.

THE ELECTRIC FURNACE COMPANY, Ltd., of 17, Victoria-street, Westminster, announces that it has received further orders for high-frequency electric furnaces for the manufacture of high grade tool steel from W. Jessop and Co., Ltd., of Sheffield, and J. Holtzer and Co., of Unieux, France. Each installation will be capable of melting about four tons of alloy steel per day.

SIMON-CARVES, Ltd., of 20, Mount-street, Manchester, announces that it has secured an order from the Whitehaven Colliery Company for firing three of its boilers with pulverised fuel. The coal to be used is "Rattler," a very low grade coal, which has up to the present been thrown away as useless. Other orders which the firm has in hand include the final extensions at the Princes Station, Nechells, of the Birmingham Corporation Electricity Department; extensions at the Peterborough Corporation's Station; and plant for the Tilmanstone (Kent) Collieries, Ltd.

IRON AND STEEL INSTITUTE.—The Council of the Iron and Steel Institute has this year decided to award two Bessemer Gold Medals, the one to Mr. Axel Wahlberg, the well-known chief engineer of the Jernkontoret, Stockholm; the other to Professor Carl Benedicks, the eminent Principal of the Metallographic Institute at Stockholm, who is likewise an honorary vice-president of the Iron and Steel Institute. Mr. F. W. Harbord, C.B.E., on taking office as president, will present these medals at the annual meeting on May 5th. Owing to the still unsettled conditions in the iron industry at the close of last year and as the result of careful inquiry among the members, it appeared exceedingly doubtful whether it would be possible to ensure a representative meeting in Canada next August as had been originally proposed. The Council has therefore, with the greatest reluctance, felt it necessary to ask the Canadian Institute of Mining and Metallurgy to postpone its invitation for a future occasion. The West of Scotland Iron and Steel Institute has now come forward with an invitation to hold the autumn meeting at Glasgow, and it has been practically settled that the meeting shall take place there in the week beginning Monday, September 19th.

THE INSTITUTION OF STRUCTURAL ENGINEERS: THE BRENFORCE TRAVELLING SCHOLARSHIP.—A scholarship of the value of £300 is to be awarded triennially by the Institution of Structural Engineers, commencing this year. It is to be known as the Brenforce Travelling Scholarship, and it is to be awarded with the object of encouraging the æsthetic design and artistic development in England of concrete and reinforced concrete. It is also to be awarded with the object of providing the opportunity for foreign travel and the great experience and benefit that such experience affords to structural engineers, more especially those interested in the design and construction of works in reinforced concrete. Every candidate who enters should therefore be prepared to give up at least six weeks of his time to travel before the end of the year 1927. The competition for the scholarship will consist of an examination in the design of a reinforced concrete structure, conducted on Beaux Arts methods. The subject will be chosen by a jury of those most eminent and fitted for such work. The winner of the scholarship will receive a gold medal, and those placed second and third may, if the jury recommend it, be awarded respectively a silver and a bronze medal. Further particulars may be obtained from the Secretary of the Institution, 10, Upper Belgrave-street, London, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 5 0 to 4 7 6	
No. 1 Foundry	4 12 0 to 4 15 0	
No. 3 Foundry	4 7 6 to 4 10 0	
N.E. COAST—		
Hematite Mixed Nos.	4 6 0	4 6 0
No. 1	4 7 0	4 7 0
Cleveland—		
No. 1	4 2 6	4 2 6
Silicious Iron	4 2 6	4 2 6
No. 3 G.M.B.	4 0 0	4 0 0
No. 4 Foundry	3 19 0	3 19 0
No. 4 Forge	3 18 6	3 18 6
Mottled	3 17 6	3 17 6
White	3 17 6	3 17 6
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	4 0 0	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	4 0 0 to 4 2 6	
Foundry Forge	3 13 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
Forge	3 18 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
No. 4 Forge	—	—
Basic	4 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 17 6 (a); 5 0 6 (b); 5 4 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 15 0	—
Best	—	—
N.E. COAST—		
Iron Rivets	12 15 0	—
Common Bars	11 15 0	—
Best Bars	12 5 0	—
LANCS.—		
Crown Bars	11 15 0	—
Second Quality Bars	10 15 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	11 15 0	—
Best Bars	12 5 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	11 17 6 to 12 0 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 15 0	—
Gas Tube Strip	13 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	11 0 0
Ship Plates, ¾in. and up	8 7 6 .. £8 0 0 to 8 5 0	
Sections	7 17 6 .. £7 10 0 to 7 15 0	
Steel Sheets, under 3/16 in. to ¼in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	— £15 7 6 to 16 0 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 10 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0†	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 0 0	—
,, (Small Round)	9 0 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 15 0	—
,, (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 0 0	
Billets and Sheet Bars	7 0 0 to 7 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	15 0 0 to 15 2 6	
Angles	7 17 6 to 8 0 0	
Joists	7 17 6 to 8 0 0	
Tees	9 0 0	—
Bridge and Tank Plates	8 17 6 to 9 2 6	
Boiler Plates	11 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/9 to 20/3
Block Tin (cash)	312 15 0
,, (three months)	299 15 0
Copper (cash)	53 12 6
,, (three months)	56 2 6
Spanish Lead (cash)	28 0 0
,, (three months)	28 8 9
Spelter (cash)	30 18 9
,, (three months)	31 2 6
MANCHESTER—	
Copper, Best Selected Ingots	62 0 0
,, Electrolytic	63 0 0
,, Strong Sheets	86 0 0
,, Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price) lb.	0 0 11½
,, Condenser lb.	0 1 1½
Lead, English	30 0 0
,, Foreign	28 15 0
Spelter	31 5 0
Aluminium (per ton)	£107

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 10 0	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 7 6	6/6
,, ,, Specially Refined		
,, ,,Max. 2 p.c. carbon	£36 2 6	11/6
,, ,, ,, 1 p.c. ,,	£42 5 0	15/-
,, ,, ,, 0.70 p.c. carbon	£54 0 0	17/6
,, ,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 12 6 scale 5/- per unit	
,, ,, 75 p.c.	£18 10 0 scale 6/- per unit	
,, Vanadium	14/9 per lb.	
,, Molybdenum	5/3 per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	9/- per lb.	

FUELS.

SCOTLAND.

(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/-
,, ,, Ell	15/9
,, ,, Splint	16/- to 17/6
,, ,, Trebles	15/9
,, ,, Doubles	15/3
,, ,, Singles	13/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/-
,, ,, Jewel	17/-
,, ,, Trebles	16/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/6 to 15/6
Screened Navigation	22/-
Trebles	15/-
Doubles	15/-
Singles	13/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/6
Secondary Steam	13/-
Trebles	14/-
Doubles	14/-
Singles	13/-

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		27/6
Household		42/6 to 52/6
Coke		30/6
NORTHUMBERLAND—		
Best Steams		17/-
Second Steams		15/6
Steam Smalls		10/6
Unscreened		15/6
Household		23/- to 30/-
DURHAM—		
Best Gas		17/9 to 18/-
Second		15/9 to 16/3
Household		23/- to 30/-
Foundry Coke		26/6 to 27/6
SHEFFIELD—		
Best Hand-picked Branch	38/-	
Best Selected House Coal	30/- to 32/-	—
Barnsley Best Silkstone	30/- to 32/-	—
Derbyshire Best Brights	30/- to 32/-	—
,, ,, House	28/- to 30/-	—
,, ,, Large Nuts	26/- to 28/-	—
,, ,, Small	18/- to 21/-	—
Yorkshire Hards	19/- to 21/-	—
Derbyshire Hards	19/- to 21/-	—
Rough Slacks	11/- to 12/-	—
Nutty Slacks	8/- to 9/-	—
Smalls	3/- to 5/6	—
Blast-furnace Coke (Inland)	20/- to 25/- at ovens.*	
,, ,, (Export)	f.o.b.	27/6

CARDIFF— (9) SOUTH WALES.

Steam Coals :	
Best Smokeless Large	23/- to 23/6
Second ,, ,,	22/6 to 23/-
Best Dry Large	21/6 to 22/-
Ordinary Dry Large	20/6 to 21/-
Best Black Vein Large	21/9 to 22/3
Western Valley Large	21/6 to 21/9
Best Eastern Valley Large	20/6 to 21/-
Ordinary ,, ,,	20/- to 20/6
Best Steam Smalls	14/6 to 15/6
Ordinary Smalls	12/- to 14/-
Washed Nuts	20/- to 23/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	17/6 to 18/6
No. 2 ,, Large	20/6 to 21/6
,, ,, Through	18/- to 19/-
,, ,, Smalls	13/- to 14/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	27/- to 27/6
Pitwood (ex ship)	34/- to 35/-
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	37/6 to 40/-
Seconds	32/6 to 35/-
Red Vein	27/6 to 30/-
Machine-made Cobbles	42/6 to 45/-
Nuts	47/6 to 50/-
Beans	42/6 to 45/-
Peas	22/6 to 25/-
Breaker Duff	8/6 to 9/3
Rubbly Culm	13/- to 14/-
Steam Coals :	
Large	22/- to 22/6
Seconds	20/6 to 21/6
Smalls	12/- to 14/-
Cargo Through	17/- to 18/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. † Latest quotations available.

(a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. * Open market price. Special price for pig iron producers, 10/- per ton at ovens.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Pact.

THERE is every indication that a collapse of the iron and steel trades has only been prevented by the operations of the Steel Cartel. At one moment it seemed very doubtful whether steel makers would be able to resist the downward movement of prices, brought about by the almost complete abstention of buyers, and many firms were offering concessions in the hope of attracting business, but at the recent meeting of the Steel Cartel at Düsseldorf decisions were come to that had the effect of consolidating the situation of producers. Since then the lower quotations have been withdrawn, and the putting up of prices to their former level has had the effect of stimulating purchases. The outlook therefore is regarded as more hopeful, although it is probable that the increased buying is largely due to the considerable contracts which are being given out by the railway companies for rolling stock. For a long while past orders for locomotives and wagons have been withheld because it was necessary to limit expenditure, but in view of the unemployment the companies are being exhorted by the Government to provide as much work as they can. Another reason for the stronger tendency of the iron and steel trades is the prospect of an early constitution of international sales *comptoirs*. At Düsseldorf the matter was discussed and approved of in principle, and preliminary negotiations are now being carried out for the creation of a *comptoir* for girders. While confidence is expressed in the final result, it is obvious that the fixing of quotas for the different countries will present great difficulties. After rails and girders, other categories of rolled iron and steel will be organised in a similar manner. The prospect of prices being maintained, and perhaps even increased by the international sales agencies has strengthened the position of the iron and steel trades, despite the decision of the Cartel at the Düsseldorf meeting to maintain the present production during the first quarter of the year. It had been decided to reduce the output by a million and a-half tons, but Germany insisted that the production should be maintained on the ground that German steel makers would be unable otherwise to supply the home market, the requirements of which have grown considerably during the past few months on account, mainly, of the development of the engineering industries. The French opposed the German proposal on the plea that British steel makers were entering the continental market, and that an over production at the present time would be disastrous; but they finally gave way on the Germans undertaking to reduce considerably the quantity of steel available for export. The admission of Poland, and consequently of the other Central European steel-producing countries, to the Cartel is still in abeyance on account of the somewhat exaggerated claims of the Polish steel makers, but it is understood that a settlement will be arrived at shortly, in which case it is hoped that the completion of the Steel Cartel, so far as the Continent is concerned, will be followed by the adhesion of British steel makers. The effect of these combinations on prices is seen in the price which has been fixed for rails to be supplied to the French railway companies during March. The quotation of 908 francs per ton is only one franc below the price ruling in December.

Marseilles Extensions.

In planning an extension of the shipping facilities at Marseilles, the idea was at first to make the port a terminus of the inland waterway system by tunnelling the Rove and constructing a canal to Arles, where it would join the Rhone, which, in turn, would be connected up with the Rhine and the waterways of Central Europe. That part of the work has been practically completed, and very shortly the Marseilles Docks will extend as far as L'Estaque. During the past few years it has been found necessary to develop the plan still further. Upon Marseilles devolves the task of providing for the traffic between North Africa and France, and apart from the commercial traffic, which will grow enormously in the future, there are strategical matters to be considered in view of the transport of African troops. It appears fairly certain that the Trans-Saharan Railway will be constructed, both for commercial and strategical purposes, and it is expected to bring an enormous amount of traffic to Marseilles. The Etang de Berre would provide ample facilities in times of emergency, but it lacks conveniences for rapid land transport, and it has therefore been decided to construct new docks in Marseilles. The area of the Joliette is to be increased from 55 to 83 acres, and adjoining it another dock, to be known as the Pharo Dock, will be constructed. The extension of the Joliette will cost 52 million francs, and it is estimated that, in addition, 30 millions will be spent upon it, including 16 million francs for warehouses and 12 million francs for the mechanical department. The new docks will be connected up directly with the P.L.M. Railway system. It is stated that when the programme is completed Marseilles will be the largest port in the world, and will be capable of dealing with a practically unlimited amount of traffic.

Wages and Work.

An interesting account of the industrial conditions in the United States was made recently before the Association Technique de Fonderie by Monsieur Coqueugnot, managing director of the Société d'Aubrives et Villerupt, who visited America on the occasion of the international foundry congress at Detroit. He denied that the conditions in the United States were so much better than they are in France, and declared that high wages were by no means general, and he mentioned numerous factories where the men worked 54 hours a week and one even where they worked 75 and 77 hours. The men earned high wages because they were paid by results, and the indifferent workmen were eliminated. The living costs were proportionately high. Moreover, in the event of unemployment, accident, illness, or old age, the men were generally thrown on their own resources. After dealing with the manufacturing methods employed in the United States, Monsieur Coqueugnot concluded by saying that there was no fear of American manufacturers controlling the market on this side.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

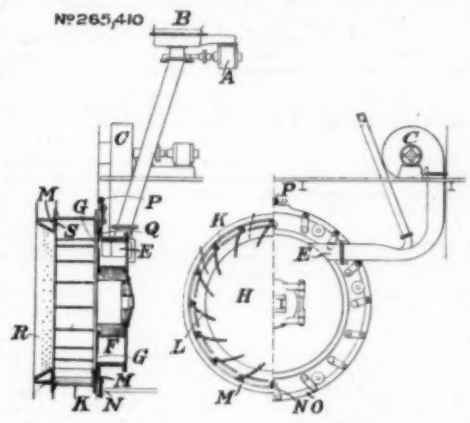
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

265,410. March 19th, 1926.—IMPROVEMENTS IN FUEL BURNERS, International Combustion, Ltd., of Africa House, Kingsway, London, W.C. 2; and Fay Harry Rosencrants, of the same address.

The pulverised fuel is fed by any known device driven by a motor A from a hopper B, through a chute into an air current produced by a fan C. From the tangential pipe E the mixture enters the chamber F, when the mixture in gyratory motion passes through the opening G into the cylindrical chamber H, where it mingles with currents of air entering the chamber through slots K and is directed towards the axis of the chamber by baffles L, pivotted to the front and back rings M. The front

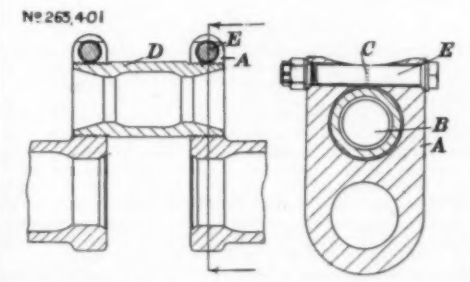


ends of the pins on which the baffles are mounted carry crank arms which are pivoted to a ring O at their outer ends so that they can be turned on the periphery of the chamber F by worm gear P. Thus the angle at which the air entering through the slots K is deflected by the baffles L can be varied by adjusting the position of the baffles by operating the worm gear by means of the lever Q. The back ring M of the chamber H has an air box R of conical section, and the inclined face is perforated to permit jets of air to enter the flame for the purpose of completing combustion and cooling the opening of the combustion chamber. The air supply to this box is obtained from the second chamber H through slots S.—*February 10th*, 1927.

INTERNAL COMBUSTION ENGINES.

265,401. March 1st, 1926.—IMPROVEMENTS IN CRANK SHAFTS, Frederick Henry Royce, of Nightingale-road, Derby.

The crank shaft described in this specification is mainly applicable to internal combustion engines in which stiffness and rigidity and avoidance of unnecessary weight are important

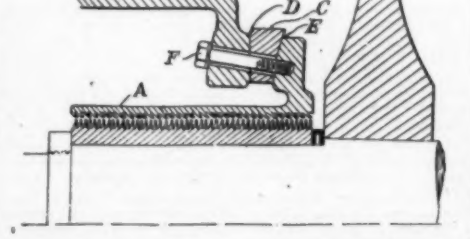


factors, as in aero-engines. The webs A have internally threaded openings B and are split at the point C. The ends of the web are cut away towards the centre to reduce the weight. The hollow pin D is threaded at each end, and the threads on this pin engage with those on the web. Bolts E with part spherical washers pass through the webs as shown.—*February 10th*, 1927.

TURBINE MACHINERY.

265,104. October 8th, 1926.—SHAFT GLAND PACKINGS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, E.C. 2, and F. Samuelson, 44, Hillmorton-road, Rugby.

This invention aims at the precise adjustment of the male

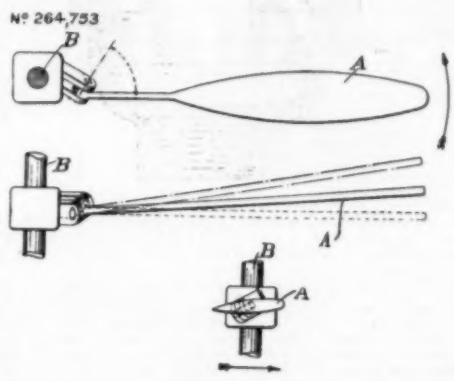


and female parts of a labyrinth packing on the shaft of a steam turbine during the process of erection. Between the female part A of the packing and the casing B of the machine there is interposed a ring C which has one truly radial face D, the other E being of spherical form. It will be seen that the combination of these two faces allows the packing gland to be adjusted both radially and angularly, so long as there is ample clearance round the holding bolts F, but this necessity is not referred to in the specification.—*February 3rd*, 1927.

AERONAUTICS.

264,753. November 24th, 1925.—ROTATIVE WINGS FOR AIRCRAFT, Juan de la Cierva, 30, Alfonso XII., Madrid, Spain.

In a "gyro-plane" the advancing wing rises by reason of the increased pressure produced by the sum of the rotary and translational velocities, while the retreating wing descends by reason of the diminished pressure produced by the difference of the velocities. In different angular positions therefore the wings work at widely varying angles of incidence. The object of this invention is to reduce the range of incidence and so to secure

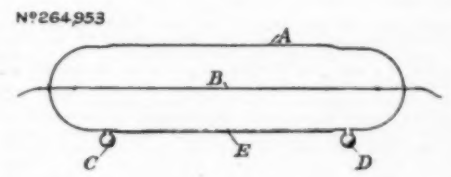


an improvement in the general efficiency of the system. The desired result is achieved by attaching the wing A to the central vertical shaft B by a hinge, the pin of which is not, as heretofore, at right angles to the shaft A, but is inclined thereto as seen both in plan and in end elevation. The effect of this double inclination of the hinge pin is superimposed on the normal harmonic variation in the angle of incidence of the wing. It is shown in the original specification that the superimposition diminishes the range of the variation.—*January 27th*, 1927.

LIGHTING AND HEATING.

264,953. November 9th, 1925.—COATED ELECTRIC FILAMENTS, *W. J. Tennant*, 111, *Hatton-garden, London, E.C.* 1.

The inventor discloses a process for the deposition of boron in a coherent form, for use as a resistance element, while, incidentally, he mentions that its hardness is such that it lies between that of corundum and diamond. In the drawing A is a glass vessel in which leading-in wires for an electric current are sealed. In this vessel a tungsten wire B is fixed to two leading in wires. To the bottom of the vessel are sealed two small vessels C and D, which are destined to contain boron halogenide. At E a quantity of mercury is disposed in the reaction vessel, in order to bind the halogen produced by dissociation. In order to precipitate boron on the tungsten wire, the latter is heated by means of an electric current to a temperature of about 1400 deg. Cent., the vessel D, which when starting is empty, is cooled with the aid of liquid air, and the vessel C is filled, for example, with boron bromide, and is maintained at room temperature. Now the boron bromide which at room temperature is sufficiently volatile, will evaporate, and, when touching the filament, will be dissociated, whereby boron will be precipitated on the wire and bromine be liberated. The bromine will be bound by the mercury E. The boron bromide



which has not been dissociated, will be condensed in the vessel D. On account of the evaporation of the boron bromide in the vessel C, the latter will be cooled to a temperature lying below room temperature. It is therefore advisable to heat the vessel to such an extent that the boron bromide always remains at room temperature. When all the boron bromide of the vessel C has been evaporated, the heating device may be transferred to the vessel D, in which a certain quantity of boron bromide has assembled, whereupon the vessel C may be cooled with the aid of liquid air. This process may be continued, and results in a firmly coherent layer of boron. It is obvious that the current which originally was sent through the tungsten wire, must be raised as the wire grows in size lest the temperature of the wire should fall during the reaction. It has been found that this does not cause any difficulties because the resistance of boron which at a low temperature is very high, is low at the reaction temperature. Thus, for example, a boron wire having a thickness of 1 mm. and a length of 5 cm., needs a tension of 3000 volts in order to arrive at incandescence. This tension should be decreased in proportion as the temperature of the wire increases, and at 1000. deg Cent. the resistance is about one million times smaller than at room temperature.—*February 3rd*, 1927.

MISCELLANEOUS.

263,813. December 23rd, 1926.—IMPROVEMENTS IN AND RELATING TO VAPOUR RECTIFIERS, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, United States of America.*

In this specification a method is described of making the metal cases of mercury vapour rectifiers gas-tight. The containers are coated with a vulcanised rubber layer either over the welded joints or over the entire surface. Preferably the parts in which the formation of pores is most probable are provided with a thicker coating than that given to the remaining parts. If a thin coating is applied to the remaining surface the cooling is not impaired to any appreciable extent. It has also been found that by coating the inside of a rectifier in accordance with the invention the tendency for the rectifier to backfire is reduced.—*February 10th*, 1927.

265,002. January 25th, 1926.—FLEXIBLE PIPE COUPLINGS, B. M. Brounell, 4656, Page Boulevard, St. Louis, Missouri.

This invention aims at the maintenance of a fluid-tight joint in ball and socket joints for pipe lines, and, in view of the draw-

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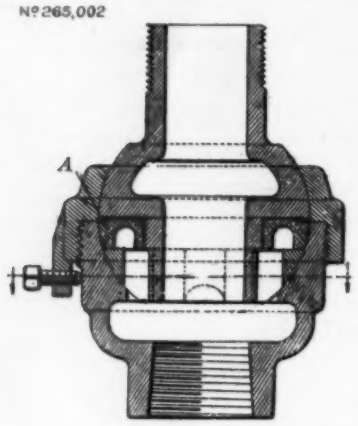

ing, requires little explanation. The cup leather A, or gasket, as the inventor names it, is expanded by the pressure of the fluid, and maintains a tight joint between the two parts.—*February 3rd*, 1927.

265,112. November 16th, 1926.—COAL WASHERS, H. E. Delcuvellerie, Montigny-le-Tilleul, near Charleroi, Belgium.

This device is primarily intended as a discharge valve on coal washers for releasing the detritus at the bottom without admitting any appreciable amount of air. It is an ordinary rotary valve, into which the detritus falls from the lower part of the washer A, when the port in its circumference registers with the

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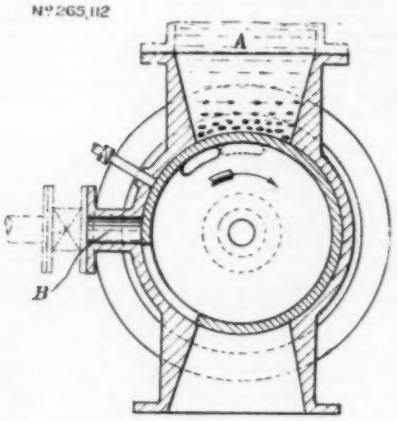

port of the bottom of the hopper. As the valve continues to rotate its port comes opposite the discharge opening below, and the detritus falls out, to be replaced by air. When the valve has turned a little further the port comes opposite a water supply B, which fills it with water and displaces the air by way of end ports at the top of its circumference, so that the air does not bubble up into the coal washer and disturb its action.—*February 3rd*, 1927.

264,576. October 19th, 1925.—IMPROVEMENTS IN AND RELATING TO THERMIONIC VALVES, The Edison Swan Electric Company, Ltd., of 123–125, Queen Victoria-street, London, E.C. 4; and Thomas Willis Price, of 14, Westfields-road, Acton, London, W. 3.

The filament leads A are fixed to the stem proper B of the bulb by being forced into metal tubes C, the ends of these tubes being embedded in the glass of the stem B. These filament leads A are held rigid and apart from each other by small bridge pieces

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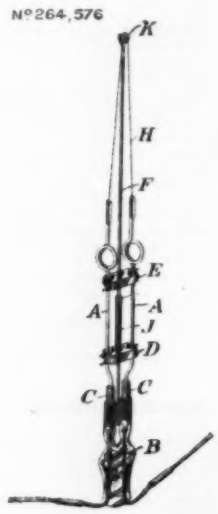

D and E of insulating material which bridge the two leads. A slidable rod F for supporting the loop of the filament H passes through aligned holes in the insulating bridge pieces. A compression spring J mounted on the filament supporting rod F works between one of the insulating bridge pieces D and a collar fixed to the filament supporting rod, while a flat shaped hook K on the end of the filament supporting rod engages with the filament loop.—*January 19th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Bush House Restaurant, Aldwych, London, W.C. 2. Dance. 8 p.m.

INSTITUTION OF CHEMICAL ENGINEERS AND THE CHEMICAL ENGINEERING GROUP.—Joint meeting with the Coventry Engineering Society. Visit to the works of Morris Motors, Ltd., Coventry. 3 p.m., meeting at the Technical Institute, Earl-street, Coventry. Lecture, "The Importance of Chemistry to the Engineer," by Professor J. W. Hinckley. 7.45 p.m.

INSTITUTION OF CIVIL ENGINEERS, INSTITUTION OF MECHANICAL ENGINEERS, INSTITUTION OF ELECTRICAL ENGINEERS.—Grand Hotel, Birmingham. Annual joint meeting of the Midland Area Graduate and Student Sections. Discussion, "That the Centralisation of Public Services is Desirable." 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Imperial Hotel, Russell-square, London, W.C. 1. Annual dinner. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Informal meeting. "Some Aspects of Workshop Organisation," introduced by Mr. F. E Robinson. 7 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—92, Victoria-street, London, S.W. 1. Metropolitan District meeting. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "An Investigation of Torsional Vibration, with particular reference to Aircraft Engines," by Mr. J. Calderwood. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. Paper, "Development of the Fiat Marine Oil Engine," by Mr. D. M. Shannon. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Colloidal Solutions," by Dr. E. Hatschek. 9 p.m.

SATURDAY, MARCH 19TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, JUNIOR SECTION.—College of Technology, Manchester. Paper, "The Application of Modern Metallurgical Knowledge to the Casting of Non-ferrous Metals," by Dr. S. F. Barclay. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Alpha Rays and Atomic Structure," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 21ST.

BRADFORD ENGINEERING SOCIETY.—Technical College, Great Horton-road, Bradford. "Modern Boiler-house Practice," by Mr. J. T. Ruddock. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "Some Notes on Petrol Engine Development," by Mr. H. R. Ricardo. 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, London, S.W. 1. Students' meeting. Discussion on "Pitfalls Encountered by Young Engineers," opened by Major James Petrie. 6 p.m.

RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Paper, "The Late History of the Great Northern Railway," by Mr. W. N. R. J. Back. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Some Industrial Applications of Electrothermics," by Mr. G. J. Finch. 8 p.m.

TUESDAY, MARCH 22ND.

ILLUMINATING ENGINEERING SOCIETY.—Lighting Service Bureau, 15, Savoy-street, London, W.C. 2. Discussion on "Various Problems in Illumination and Practical Solutions." 6.30 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—The Engineers' Club, Waterloo-street, Birmingham. "Nickel-iron and Related Alloys," by Mr. W. T. Griffiths. 7 p.m.

INSTITUTION OF AERONAUTICAL ENGINEERS.—Junior Institution of Engineers, 39, Victoria-street, London, S.W. 1. Paper, "Aircraft Law," by Mr. L. A. Wingfield. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Paper, "Heat Transmission and the Motor Car Radiator," by Professor W. E. Dalby. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "X-Rays and the Chemical Molecule," by Dr. G. Shearer. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Duralumin," by Dr. L. Aitchison. 7.30 p.m.

WEDNESDAY, MARCH 23RD.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—The Engineers' Club, Albert-square, Manchester. Paper, "Some Notes on Petrol Engine Development," by Mr. H. R. Ricardo. 7 p.m.

THURSDAY, MARCH 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Training School of Vauxhall Motors, Ltd., Luton. Paper, "Cellulose Finish for Motor Cars, with Special Reference to Belco (Duco) Finish," by Mr. C. E. Pratt. 7.30 p.m.

FRIDAY, MARCH 25TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Annual dinner. 7 for 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Electricity in the Works Laboratory," by Mr. R. E. Snoxell. 6.15 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Educative Influence of Aircraft Inspection," by Major H. Myers. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "The Exhaust Injector," by Mr. J. C. Metcalfe. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Joint meeting with the Society of Chemical Industry. "Lubrication," by Dr. W. R. Ormandy. 5.15 p.m. (Change of hour).

INSTITUTION OF MECHANICAL ENGINEERS.—Comedy Restaurant, Panton-street, London, W. 1. Annual dinner of the Graduates' Section. 7.15 for 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W 1. Lecture, "Notes on the Construction and Plant of the New Filtered Water Installation for the Seville Waterworks Company," by Mr. S. R. Broderick. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. "Pure Science: the Service it has Already Rendered to Engineering and a Review of Modern Developments and their Possible Future Application," by Sir Richard Glazebrook. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Thunderclouds," by Professor C. T.R. Wilson. 9 p.m.

SATURDAY, MARCH 26TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' afternoon visit to the works in progress at West India and Millwall Docks.

INSTITUTION OF MECHANICAL ENGINEERS.—Graduates' Section visit to the Port of London Authority's Royal Victoria, Albert and King George V. Docks. 10.30 a.m. Western entrance to the Victoria Dock.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Westoe-road, South Shields. North-Eastern District meeting. 2.15 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Guildhall, Rochester. South-Eastern District meeting. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Midland District meeting at Leighton Buzzard, Beds. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Manchester. Joint meeting of the Yorkshire and North-Western Districts. Discussion, "Manchester and District Joint Town Planning Report," opened by Mr. R. Bruce. 2.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Alpha Rays and Atomic Structure," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 28TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. Annual lecture, "Torpedo Boats and their Machinery," by Sir J. E. Thornycroft. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Some Industrial Applications of Electrothermics," by Mr. G. I. Finch. 8 p.m.

WEDNESDAY, MARCH 30TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street Westminster, London, S.W. 1. Students' Meeting. Paper, "The London County Council Becontree Housing Estate," by Mr. V. F. Cornish. 6.30 p.m.

LIVERPOOL ENGINEERING SOCIETY.—9, The Temple, Dale-street, Liverpool. Paper, "Properties of Steel at High Superheated Temperatures," by Dr. Andrew McCance. 6 p.m.

NEWCOMEN SOCIETY.—Prince Henry's Room, 17, Fleet-street, London, E.C. 4. Paper, "Notes on Lead Mining and Smelting in West Yorkshire," by Mr. A. Raistrick. 5.30 p.m.

THURSDAY, MARCH 31ST.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Tare and Load Compared in Modern Locomotives and Rolling Stock," by Mr. A. M. Bell. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the Brush Manufactory of Beechwood, Ltd., Chesham, Bucks. 2.45 p.m.

FRIDAY, APRIL 1ST.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Chamber of Commerce, New-street, Birmingham. Lecture, "The Testing of Heat Engines," by Mr. H. R. J. Burstall. 6 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Room 24, Royal Technical College, George-street, Glasgow. Annual general meeting. 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE directors of Vickers, Ltd., have appointed Mr. F. C. Yapp a member of the firm's armaments and shipbuilding management board.

MR. F. J. CLEVELAND asks us to announce that he has voluntarily given up his position as chief technical assistant to J. S. Withers and Spooner, and has opened an office at Bank Chambers, 29, Southampton-buildings, Chancery-lane, W.C. 2.

YOUNG, OSMOND AND YOUNG, Ltd., late of Stafford House, Norfolk-street, London, W.C. 2, ask us to announce that their address now is Excelsior Works, The Broadway, Bexley Heath, Kent, and that their telephone number is Bexley Heath 519.

W. DEDERICH, Ltd., of Stanley House, Dean Stanley-street, Westminster, London, S.W. 1, asks us to state that a new company has been formed under the style of the Transporting Machinery and Engineering Company, Ltd., of the same address, for the purpose of taking over the mechanical handling department of W. Dederich, Ltd.

BASINGSTOKE ELECTRICITY WORKS.—On the afternoon of Thursday, February 24th, took place the official putting to work of a new oil engine-driven generating set which has been supplied by Mirrlees, Bickerton and Day, Ltd., of Hazel Grove, near Stockport. The set comprises a six-cylinder Mirrlees-Diesel engine of 600 B.H.P. coupled direct to a G.E.C. generator designed to run at the normal speed of 250 R.P.M. The engine is of the long-stroke type and it embodies the features which were referred to in our issue of February 5th, 1926, when we illustrated and described the previous set, which was supplied by the same firm of engine builders.

FEDERATION OF BRITISH INDUSTRIES.—At a meeting of the Grand Council of the Federation of British Industries, held on March 9th, Lord Gainford was nominated as president-elect of the Federation, in succession to Sir Max Muspratt. The following were also nominated for election to the ranks of vice-presidents, in addition to those already holding that office:—Sir Rowland Blades, of Blades, East and Blades; Sir Harold Bowden, chairman and managing director of the Raleigh Cycle Company, Ltd., &c.; Sir David Brooks, G.B.E., chairman, Birmingham District F.B.I., since 1917; Sir Eustace Tennyson D'Eyncourt, of Sir W. G. Armstrong-Whitworth and Co., Ltd.; Mr. Forrest Hewit, director of the Calico Printers' Association and deputy chairman of Manchester District F.B.I.; Mr. H. W. Lee, chairman of the Fine Cotton Spinners' and Doublers Association; Sir William Clare Lees, of the Bleachers' Association; Sir Frederick Lewis, of Furness, Withy and Co., Ltd.; and Sir George Truscott, of James Truscott and Sons, Ltd. The election will take place on March 30th.